

OPERATING INSTRUCTIONS
380-HP, 44-TON DIESEL-ELECTRIC

RAILROAD LOCOMOTIVE

CLASS B-B-88/88-4GE733

(Serial No. 18145 and above)



GENERAL ELECTRIC COMPANY
AMERICAN LOCOMOTIVE COMPANY
SCHENECTADY, N. Y

FOREWORD

A diesel-electric locomotive is easy to operate-and is far more easily operated when one has a good understanding of what it can do when kept in good condition. The diesel-electric system, all controlled by a single throttle, is inherently simple : an engine drives a generator which sends current to electric motors that are geared to the wheels. General Electric has issued this manual to help the operator by explaining how to operate the locomotive and how it operates.

The operator who wants to know more about his work will find this book helpful. It will explain how the locomotive actually works. Through this knowledge he will be far better equipped to deal with the casual troubles that he may encounter. Many illustrations are used. Brief descriptions and photographs of equipment, and diagrams of electric circuits are included for the operator who wants a working knowledge of what happens when he presses a button, operates a valve, or opens the throttle.

An operator should know the places needing lubrication, the proper lubricants and fuel to use, and how often the locomotive must be lubricated. This knowledge will help him avoid certain difficulties and to get more satisfaction out of the continuous operation of a well-cared-for locomotive.

*FROM THE COLLECTION OF
CHRIS JACOBS*

ACTUAL PAGE SIZE 5 1/4 x 7 3/4

*SOME PAGES ROTATED FOR SCREEN
PRESENTATION*

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Section 1

Locomotive Data

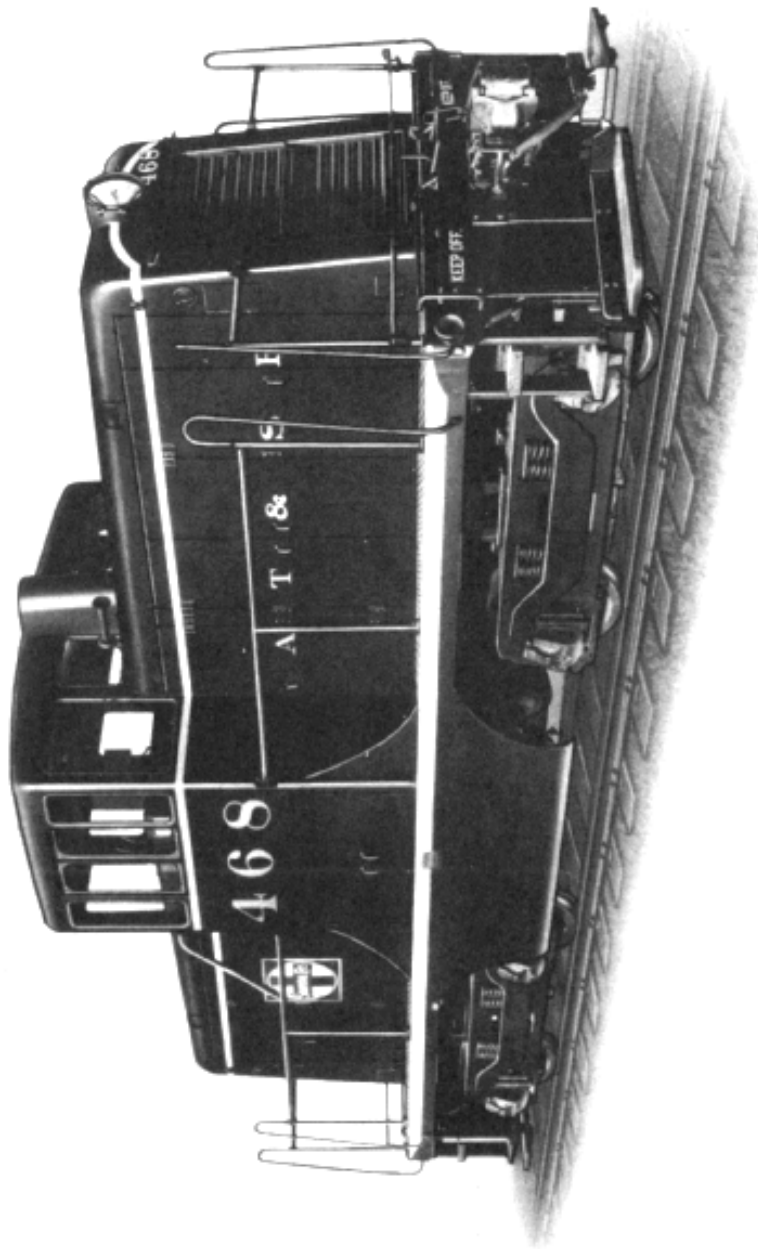
380-HP DIESEL-ELECTRIC LOCOMOTIVE

General Data

Wheel arrangement.....	B- B (404)
Weight with running supplies- (approx) . .	88,000 lb
Fuel-oil-tank capacity.....	250 gal
Lubricating-oil-system capacity (one engine).	50 gal
Cooling-water-system capacity (one engine).	40 gal
Sand-box capacity (total).....	800lb
Maximum permissible speed	35 mph
Minimum radius curvature-locomotive alone.	50 ft
Minimum radius curvature-coupled to 40-ft freight car.....	125 ft
Total engine brake horsepower.	380 hp
Number and type of engines.. . . .	Two, D-17000
Number and type of traction gen erators	Two GT-555
Number and type of auxiliary gen erators..	Two, GM G-140
Number and type of traction motors..	Four, GE-733
Motor gear ratio	11.25 to 1 (double reduction)
Air brakes.....	Schedule 14-EL (Combined straight and automatic)
Air compressor. Two air-cooled, two-stage displacement, 48 cu ft each	

Approximate Weights of Parts

	Lb
Cab and underframe complete (tanks empty)	55,000
Engine hood with doors.....	2000
Engine-generator set complete.....	10,500
Diesel engine (dry).....	8800
Generator with coupling and pulley.....	3700
Truck complete with two motors.	15,000
Traction motor complete with gear unit.	2500
Traction motor.....	1100
Traction-motor gear unit.....	1400



380-HP DIESEL – ELECTRIC LOCOMOTIVE

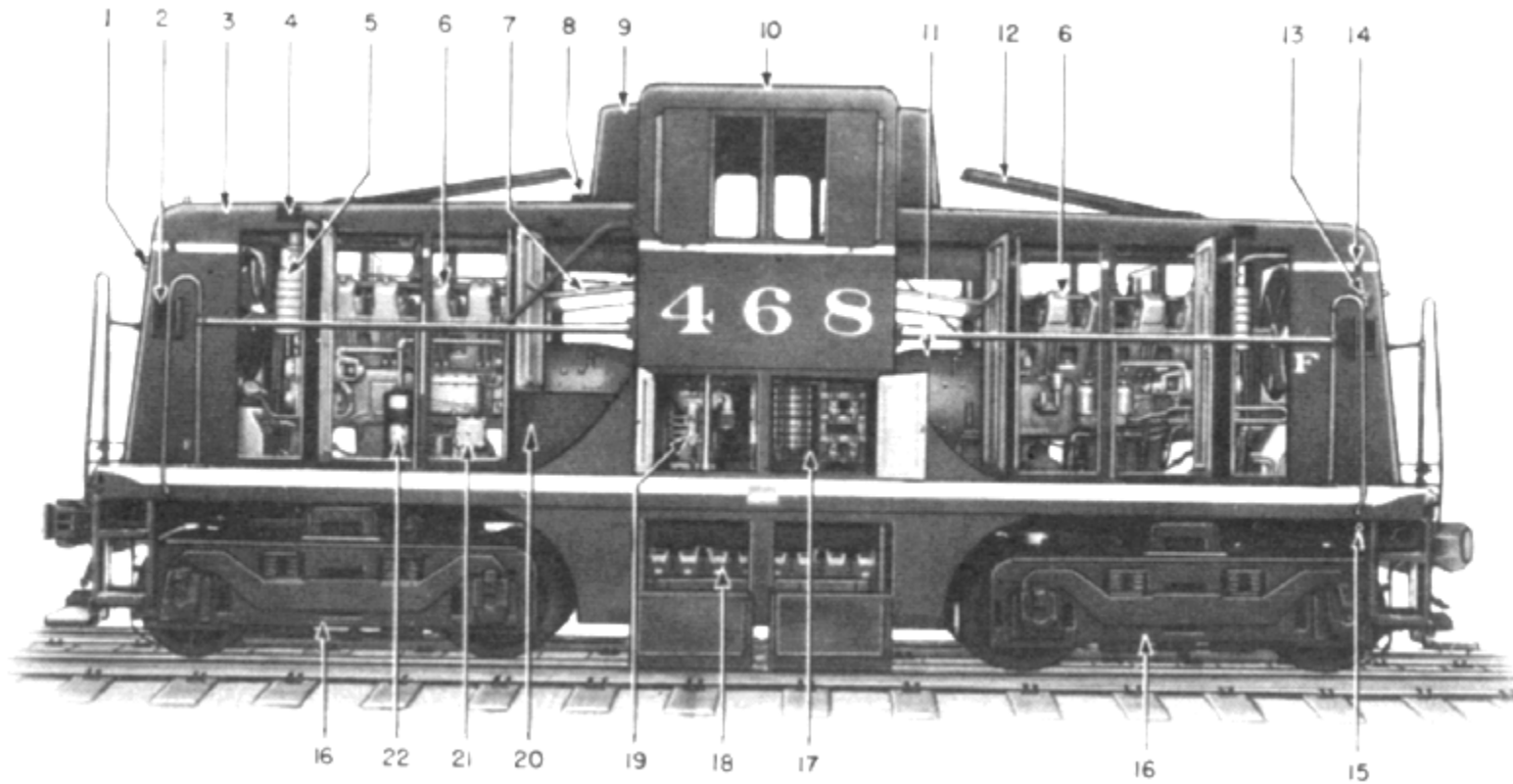


Fig. 1. G.E.-Alco 380-hp, 44-ton diesel-electric railroad locomotive, side view

- | | | |
|---|----------------------------------|--|
| 1. Grab rail | 9. Engine exhaust stack | 17. Reverser and field-shunting contactors |
| 2. Sand-box filler | 10. Operator's cab | 18. Storage battery |
| 3. No. 1 radiator filler for antifreeze | 11. Traction generator | 19. Air compressor |
| 4. Air intake for diesel engine | 12. Roof hatch | 20. Generator air-exhaust opening |
| 5. Air cleaner | 13. Marker-light receptacle | 21. Lubricating-oil filter |
| 6. Diesel engine | 14. Signal flag and lamp bracket | 22. Kerosene circulating-water heater |
| 7. Baffle over generator & Horn | 15. Radiator filler | |
| | 16. Truck | |

LOCOMOTIVE DATA

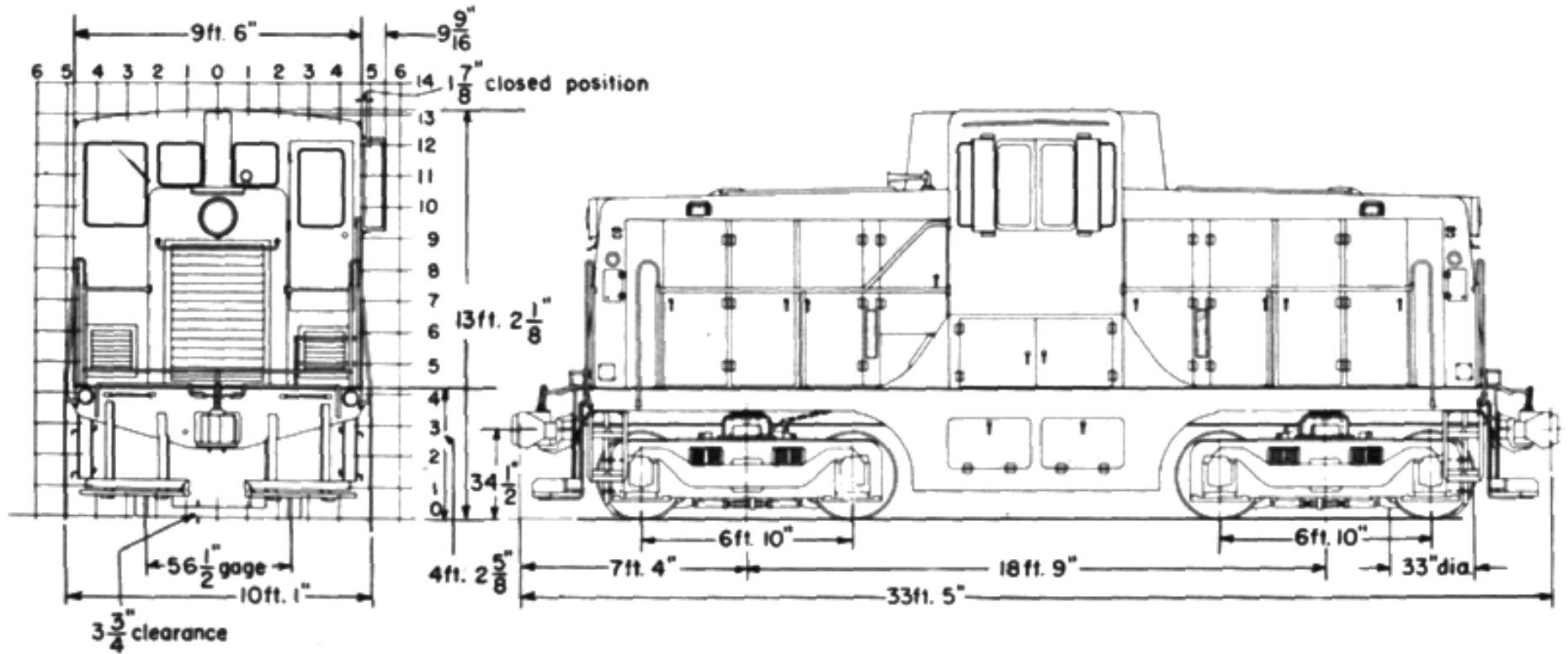


Fig. 2. Outline of G.R.-Alto 380-hp, 44-ton diesel-electric railroad locomotive

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Section 2

How to Operate the Locomotive

General Operating Rules

1. Speed limit is 35 mph.

Do not operate locomotive at higher speeds, either on its own power, coasting down grade, or being towed. Overspeed will cause "flashover" of the motor commutators, mechanical failure of the rotating parts of the motors, or both.

2. Do not overload locomotive.

Do not operate locomotive with throttle wide open for more than one hour at a time. Observe the load indicators frequently.

The indicator pointer when in the green band indicates that the load is safe for all classes of service.

The indicator pointer when in the yellow band indicates that the load is safe for switching, and for short runs in transfer or haulage services.

The indicator pointer when in the red band indicates that the load is safe only for switching and starting.

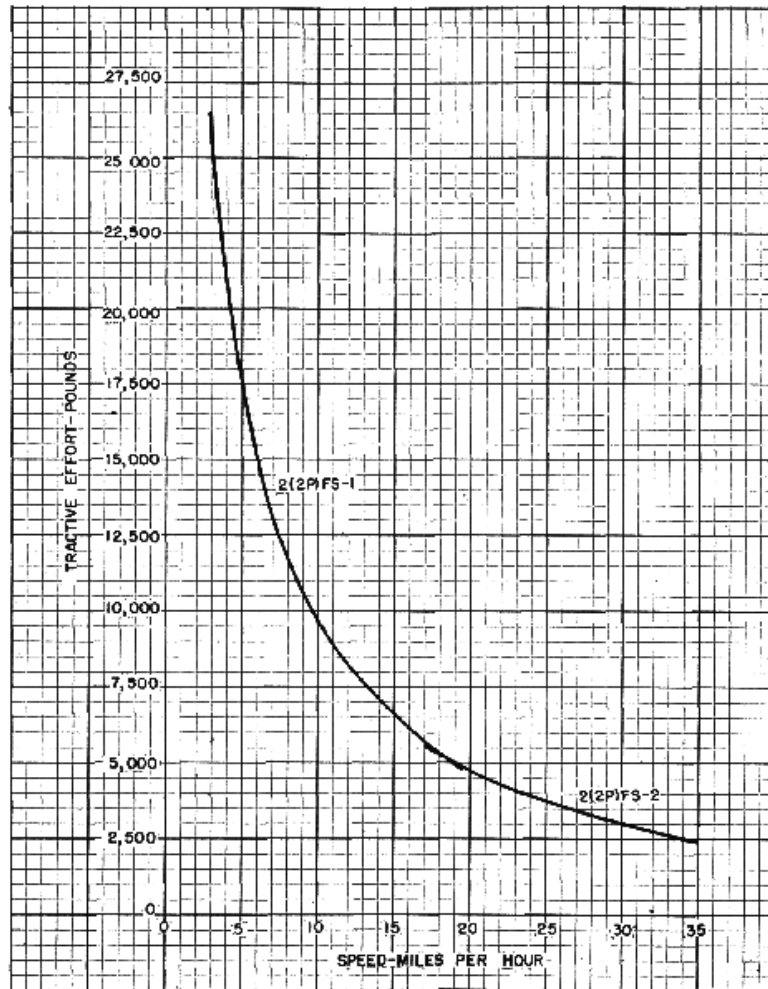
3. Observe the following air-brake rules;

- (a) Release *air brake on train before detaching locomotive.*

Set sufficient hand brakes on the cars to hold the train. This is especially important on a grade, because there is otherwise no assurance that the car, cars, or train so detached will not start when the air brakes leak off, as they may in a short time where there is considerable leakage.

- (b) *Never use the automatic brake to hold locomotive or train at standstill.*

The automatic brakes should never be used to hold a locomotive or a train while standing, even where the locomotive is not detached, for longer than ten minutes, and not for such time if the grade is very steep or the condition of the brakes is not good. The safest method is to hold with hand brakes only and keep the



EQUIPMENT

2-190-hp, 1000-rpm Diesel Engines
 2-GT-555 Generators
 4-GE-733 Railway Motors

Gear Ratio, 11.25:1
 Wheel Diameter, 33 Inches

Based on 165 hp available to each Generator at 1000 rpm for traction

Fig. 3. Speed-tractive-effort curve of G.E. Alco 380-hp, 44-ton diesel-electric railroad locomotive

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auxiliary reservoirs fully charged, to guard against a start from brakes leaking off, and to be ready to obtain any part of full braking force immediately on starting.

(C) *Use the independent brake for holding at standstill.*

The independent brake is a very important safety feature in this connection, since it will hold a locomotive or quite a heavy train on a fairly steep grade if, as the automatic brakes are released, the slack is prevented from running in or out (depending on the tendency of the grade), and giving the locomotive a start.

(d) *Apply independent brake when leaving control station.*

When leaving the locomotive, while doing work around it, or when it is standing, always leave the independent-brake handle in application position.

(e) *Prevent loss of main-reservoir pressure.*

After an emergency application of the brakes while running over the road, due to any cause other than intended by the operating engineer, move the brake-valve handle to Lap position to prevent loss of main-reservoir pressure. After the train stops, the cause of the application should be located and remedied before proceeding.

(f) *Be sure brakes are in good condition before leaving terminal.*

Before leaving the roundhouse, the engineer should try the brakes with both brake valves, and see that no serious leaks exist. The pipes between the distributing valve and the brake valve should be absolutely tight.

The safety-valve operation and adjustment should be tested at this time, and also on arrival at terminal. Any needed adjustment should be made. Otherwise, a necessary emergency application may give too little or too much holding force. To determine adjustment of the safety valve, place the automatic-brake-valve handle in *Emergency* position and observe the pressure on the brake-cylinder gage at which the safety valve opens. This pressure should be between 65 and 70 lb. Return the brake-valve handle to Lap position, and observe the pressure at which the safety valve closes. The safety valve should be adjusted to 68 lb. It is assumed that this test will always be made on the locomotive alone, that is, before the brake pipe is connected to the train.

HOW TO OPERATE THE LOCOMOTIVE

4. *Watch gages.*

All gages, such as air-pressure, oil-pressure, battery-charging, load indicators, and engine water-temperature must be observed frequently during operation, to detect indications of trouble.

5. *Never apply sand while wheels are slipping.* (See Fig. 5A.)

Close throttle until slipping stops. Sand rails by operating sander valve, then advance throttle slowly. Make certain sander valve is off when not required.

6. *If idle time is to be greater than ten minutes, shut down diesel engine after idling five minutes.*

This will save diesel-engine fuel and reduce engine operating hours. Upon starting again after a brief idle period, locomotive may be moved after air and oil pressure and cooling-water temperature are correct.

7. Set hand brake.

If diesel engine is shut down and locomotive is left standing, set hand brake to prevent locomotive movement if air supply fails."

Daily Preparation for Running

1. Open battery switch, and keep it open while making daily inspection. Tie a caution tag on the switch. The tag should be removed only by the same man who placed it on the switch.

2. Inspect entire locomotive, including commutators and electric devices and connections, for the presence of rags, tools, paint, dirt, or other foreign material. Also see that there are no loose nuts, bolts, or cap screws, or any parts worn to such an extent that they are no longer serviceable.

3. See that all generator and motor commutator covers are replaced and securely fastened.

4. With the battery and control switches open, operate by hand all relays and contactors, to see that they have free action and do not bind.

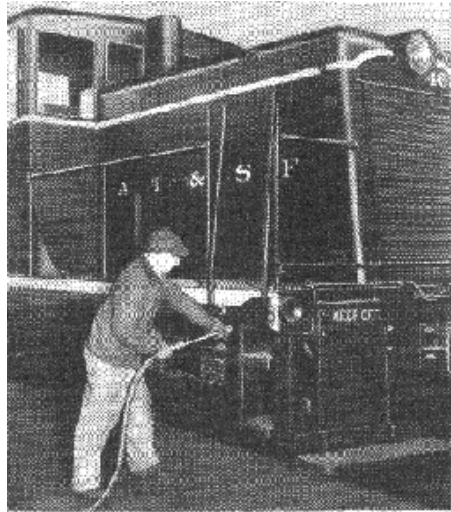
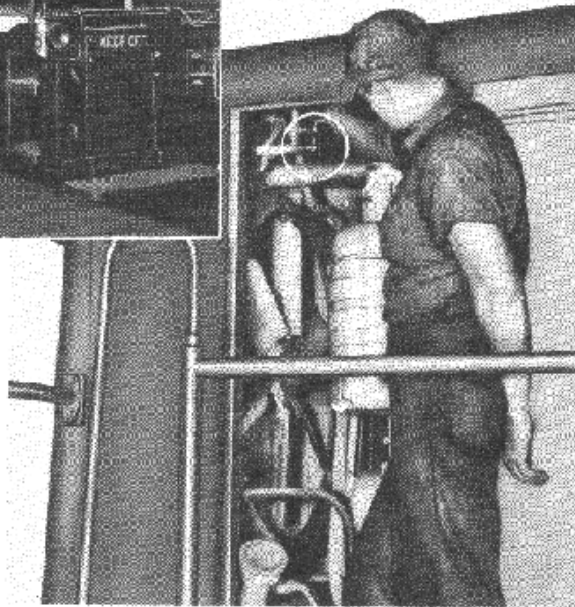


Fig. 4A. Filling the radiator

Fig. 4B. Checking water level



5. See that hand-operated valves in water and oil lines are in their proper operating positions.

6. Fill engine cooling system with clean soft water (see Fig. 4A) or with the proper antifreeze solution if temperature is or will be below freezing.

7. Check water level every shift. Water should run out of upper try-cock (see Fig. 4B). If it does not, add more water. Failure of water to run out of lower try-cock indicates water level is dangerously low. Do not operate engine under this condition. Do not add cold water when water is low and the engine is hot.

8. Fill fuel tank with clean diesel-engine fuel. See fuel recommendations in Section 7. At least once a week, open the drain valve on the fuel tank and drain off accumulated water and sediment.

9. Lubricate the locomotive. Follow lubrication diagram in Section 7.

10. Check with a hydrometer the specific gravity of the electrolyte of one or two cells of the storage battery. Check the water level. Do not add water higher than one quarter inch below the top of the filling tube. It should not be necessary to add water more than once or twice a month. If one cell takes an excessive amount, check for leakage or overcharging.

11. Operate roof hatches and radiator shutters; see that they move freely.

12. Close battery switch.

13. Test all lights.

14. Close the drain cocks in the reservoirs, the brake-pipe angle cocks at each end of the locomotive, and the dead-engine cutout cock. See that all the following cocks are open: main-reservoir cutout cock, brake-cylinder cutout cocks; doubleheading cock under the brake valve; distributing-valve cutout cock; unloader pilot-valve cutout cock; cutout cocks to reverser, horn, and sanders.

15. Start each diesel engine. Follow Engine-starting Instructions on pages 18 and 19.

16. After the engines are running, check the following:

a. See that diesel-engine lubricating-oil pressure is 30 lb or higher.

b. See that main-reservoir air pressure builds up to 135 lb.

c. See that air-compressor governor cuts out at 135 lb.

d. See that air brakes operate properly. Make the following tests

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Test No. 1. When the system is charged and the governor stops the compressor, note whether a leak occurs at the service exhaust port of the automatic portion of the brake valve when the handle is in *Release*, *Running*, *Holding*, or *Lap* positions. Leakage at this point indicates that the equalizing piston valve is leaking. If this leakage is caused by foreign matter on the valve seat, it can usually be corrected by closing the cutout cock underneath the brake valve, then making a heavy service application and returning the handle to *Release* position. The heavy blow caused at the exhaust fitting usually removes the obstacle and allows the equalizing piston valve to seat.

Test No. 2. Move the automatic-brake-valve handle to the *Service* application position and allow it to remain there until the brake-pipe pressure is entirely exhausted. Move the handle to the *Lap* position, to determine if there is leakage at the rotary valve. Leakage at the valve will be indicated by a blowing at the service exhaust fitting as the brake-pipe pressure is increased, or by an increase of pressure in the equalizing reservoir, as shown on the gage, and by an intermittent blow at the safety valve caused by the increase in the brake-cylinder pressure.

Test No. 3. Make a partial *Service* application with the independent portion of the brake valve, then lap the valve. If brake-cylinder pressure increases up to the amount for which the reducing valve is adjusted, it indicates leakage of the independent rotary valve. If brake-cylinder pressure increases to brake-pipe pressure, it indicates leakage of the distributing-valve equalizing slide valve.

Test No. 4. If the locomotive brakes release after a *Service* application, air is leaking from the application cylinder or the application-cylinder pipe. Leakage at the brake-cylinder exhaust port of the distributing valve when the locomotive brakes are applied indicates a leaking exhaust valve, while an increase of pressure above that put into the brake cylinder at the time of an application or blowing of a safety valve indicates that the application valve is leaking. Leakage past the equalizing slide valve is indicated by blowing at the exhaust port of the automatic portion of the brake valve when both handles are in the *Running* position.

HOW TO OPERATE THE LOCOMOTIVE

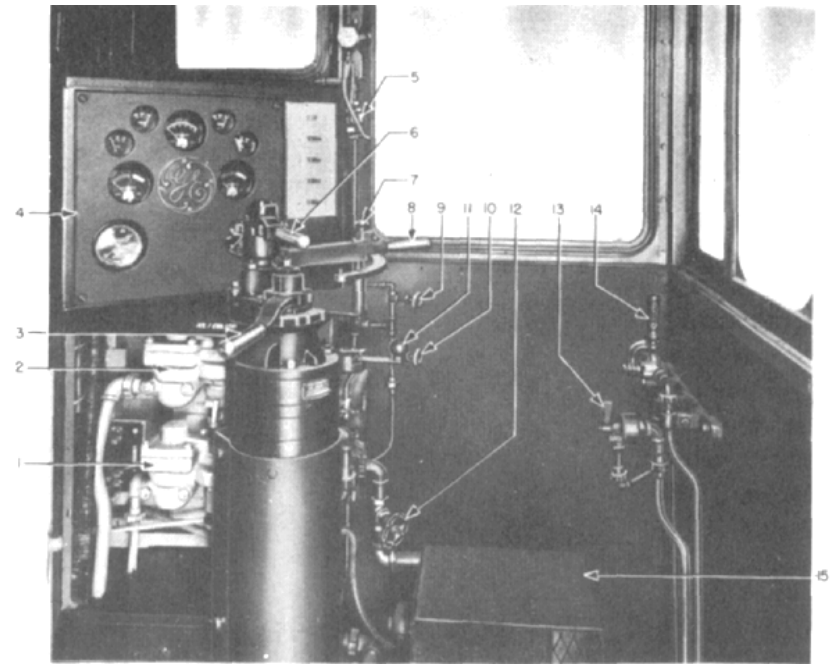


Fig. 5A. Engineman's control station and gage panel

1. Feed valve for automatic brake
2. Reducing valve for independent brake
3. Automatic-brake-valve handle
4. Gage panel
5. Horn valve
6. Independent-brake-valve handle
7. Notching cutout button
8. Throttle
9. Window-wiper operating valve No. 1 end
10. Window-wiper operating valve No. 2 end
11. Reversing handle
12. Cab-heater water-shutoff-valve handle
13. Bell-ringer-valve handle
14. Sander-valve handle
15. Cab heater

A leaky graduating valve may be detected by increase in brake-cylinder pressure when the handle of the automatic portion of the brake valve is in *Lap* position after an ordinary *Service* application, provided the reduction is not sufficient to give equalization between pressure chamber and application chamber and application cylinder.

e. See that battery is receiving charge as indicated by the battery voltmeter pointer being in its proper band. See pages 53 and 55.

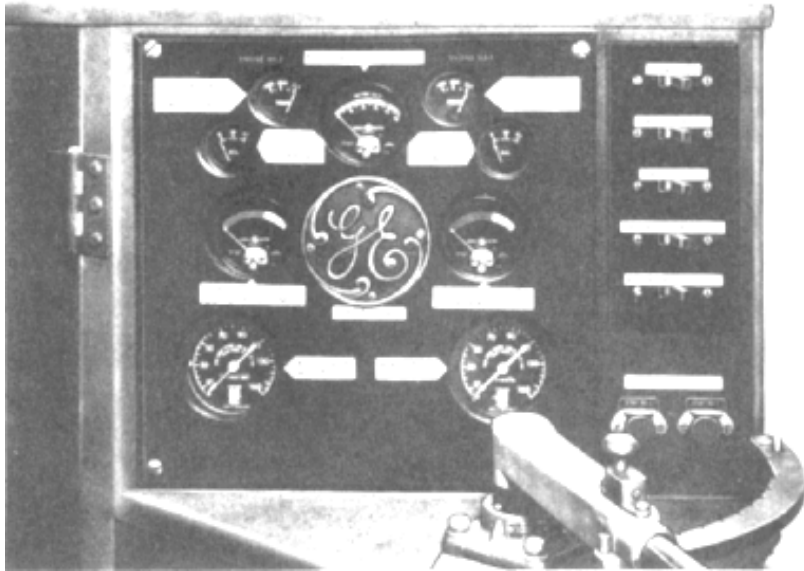


Fig. 5B. Gage panel

- f. See that window wipers operate.
- g. See that bell rings.
- h. See that sanders work.

Starting the Diesel Engine

1. *Inspect diesel-engine compartment.*
See that no waste, rags, tools, etc., are near any running part or electric equipment.
2. *Close battery switch.* (See Fig. 18.)
This switch disconnects all circuits from the battery. Close it for locomotive operation, and open it whenever inspecting or repairing equipment and when leaving the locomotive.
3. *Close exciter-field cutout switch.* (See Fig. 18.)
Both of these switches should be closed for normal locomotive operation.
4. *Close motor cutout switches.* (See Fig. 18.)
All must be closed for normal locomotive operation.

5. *Close control switch.* (See Fig. 5A.)
This switch disconnects all control circuits from the battery. Close it for locomotive operation, and open it when inspecting or repairing equipment and when leaving the locomotive.
6. *Place engine compression-release lever in the Run position.* (See Fig. G.)
This lever is located on the right side of the engine, and must always be in the Run position, except when making repairs or testing.
7. *Place reverse handle in Off position.* (See Fig. 5A.)
Always have reverse handle in Off position when starting engines, to prevent locomotive movement.

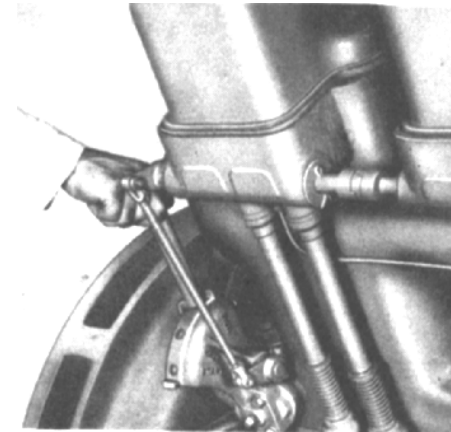


Fig. 6. Compression-release lever in Run position

8. *Place throttle in Idling position.* (See Fig. 5A.)
For starting the diesel engines, the throttle must be in the Idling position, except for cold-weather starting, when it may be advanced slightly to prevent engine from stopping after it has fired.
9. *Close No. 1 Engine-start switch.* (See Fig. 5A.)
Keep diesel-engine starting switch closed until engine is firing regularly. Spring return opens starting circuit when the switch is released.

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10. *If diesel engine does not start*, refer to pages 32 and 57.
11. *Observe oil-pressure gage.* (See Fig. 5B.)
Oil-pressure gage for each engine must read 30 lb or higher before operating the locomotive.
12. *After the first engine is running and the oil pressure is normal, start engine No. 2 in the same manner.*

Before Moving Locomotive

1. *Start diesel engines.*
Complete all 12 steps on pages 18 to 20.
2. *Observe main-reservoir air pressure.* (See Fig. 5B.)
See that air compressors pump main-reservoir pressure up to 135 lb and then cut out.
3. *Observe cooling-water temperature.*
This must be between 140 and 170 F before locomotive is moved.
4. *Release hand brake.*
Hand brake is used only to hold locomotive while not in motion. It should not be used for braking locomotive, except in cases of emergency.
5. *Apply brake handles on valves.*
Place the handles on the brake valve (the cutout cock underneath it being open) and move them to Running position.
6. *Observe brake-pipe pressure.*
Do not attempt to move the train (or locomotive) until the brake-pipe gage hand shows full brake-pipe pressure.
7. *Test air-brake operation.*
Check air-brake operation before locomotive is moved. See that brake shoes actually apply and release.

Operating the Air Brakes

The following instructions cover, in a general way, the proper method of handling the No. 14-EL equipment in service, but do not apply rigidly to all individual cases or conditions. Specific instructions are usually issued by each railroad to cover its own recommended practice in accordance with local operating conditions.

HOW TO OPERATE THE LOCOMOTIVE

The instructions for manipulating the EL equipment are practically the same as those for the No. 6-ET equipment which is standard for use on steam locomotives; therefore, no radical departure from present methods of brake manipulation' is required to get the desired results.

1. *Automatic-brake operation.*

(a) Running

When not in use, carry both brake-valve handles in Running position.

(b) Service

To apply the brakes in service, move the handle of the automatic-brake valve to the *Service* position, making the required brake-pipe reduction, then back to Lap position, which is the one for holding all the brakes applied.

(c) Release

As a rule, it is safest to come to a stop before releasing the brakes on a freight train, especially a long one, rather than attempt to release at low speed. However, if conditions permit the release while in motion, the brake-valve handle should be moved to *Release* position and held there long enough to move as many of the triple valves to Release position as possible, without unduly overcharging the head end of the train (the time in Release position should be governed by the length of train, amount of reduction made, etc.). Return to Running position to release the locomotive brakes and complete the recharging of the auxiliary reservoirs. A few seconds after such a release, particularly on long trains, it is necessary to again move the handle to Release position and quickly back to Running position to "kick off" any brakes at the head end of the train that may have reapplied because their auxiliary reservoirs have been slightly overcharged.

(d) Holding Locomotive Brakes Applied

If, when releasing as explained above, it is desired to hold the locomotive brakes applied after the other brakes release, move the handle from *Release* back to Holding instead of Running position. Release the locomotive

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brakes fully by moving the handle to Running position, and leave it there, or graduate them off, as circumstances require, by short successive movements between *Holding* and *Running* positions.

(e) Emergency

To apply the brakes in emergency, move the handle of the automatic-brake valve quickly to Emergency position, and leave it there until the train stops and the danger is past.

2. *Independent-brake operation.*

(a) Using Independent Brake Only.

When using the independent brake only, the handle of the automatic-brake valve should be carried in Running position. The independent application may be released by moving the independent-brake-valve handle to Running or Release position.

(b) Releasing Brakes on Locomotive Only

When all brakes are applied automatically, to graduate off or entirely release the locomotive brakes only, use Release position of the independent-brake valve.

(c) Watch Brake-cylinder Pressure

The red hand of one air gage will show at all times the pressure in the locomotive brake cylinders. Watch this hand when manipulating brakes.

(d) Release

Release position of the independent-brake valve will quickly release the locomotive brakes under any and all conditions. If, when the locomotive is coupled to a train, the locomotive brake reapplies after being released, make a "kick off" with the automatic-brake valve by moving the handle quickly from Running position to Release and return to Running. The reason for the reapplication is that the pressure chamber of the distributing valve is charged higher than the brake pipe, and causes the equalizing slide valve to move into service, and then service lap, position. This closes the release pipe and prevents the release of the application cylinder pressure with the brake valves in Running position. Releasing with the independent-brake valve in Release

HOW TO OPERATE THE LOCOMOTIVE

position under these conditions will release the locomotive brake but will not insure against a reapplication.

3. *Double-heading Operation.*

When two locomotives are coupled together, the brake-pipe hose must be coupled between the two locomotives and their cutout cocks opened.

Where there are two or more locomotives in a train, the instructions already given remain unchanged so far as the leading locomotive, or the locomotive from which the brakes are being operated, is concerned.

Close the double-heading cock under the brake valve of the second locomotive, and place the handle of the automatic-brake valve in Running position. The brakes of this locomotive can then be operated from the first locomotive, the same as those in the train. If the engineman on the second locomotive finds it necessary, he can prevent the application of the brakes on the second locomotive by placing the independent-brake-valve handle in *Release* position. If the brakes on the second locomotive are applied and there is danger of overheating the tires, or if the drivers should slide, the brakes can be released by moving the independent-brake-valve handle to *Release* position. This may be reapplied later, if necessary, by using the independent-brake-valve handle in the usual way, provided the handles of the independent- and automatic-brake valves on the second locomotive are left in *Running* position after the operation. This does not interfere in any way with the brakes on the second locomotive being released afterwards from the first locomotive in the usual way. The pressure in the brake cylinders on the second locomotive should never be reduced in this manner, except when absolutely necessary.

Moving the Locomotive

1. *Set reverser handle.*

Before opening throttle, place the reverser handle in either the *Forward* or *Reverse* position, depending on the direction of desired movement. Never attempt to move the reverser from one position to another while the throttle is open, or before the locomotive has come to a dead stop.

2. Starting.

Open the throttle steadily, and as rapidly as possible without slipping the wheels. Opening the throttle increases the speed of the diesel engines, causing them to deliver more power to the generators. This supplies more current to the motors, thus producing acceleration of the locomotive.

3. Running.

The throttle has a notched quadrant and a thumb-operated latch for holding the throttle in any desired position. It is not necessary to advance the throttle one notch at a time. If desired, the latch can be held out of engagement by means of the knob on the top of the throttle lever. Avoid jerking or swinging movement of the throttle. A positive, steady movement is best.

Stopping the Locomotive

1. Stopping.

When coasting or preparing to stop, return the throttle to the Idling position. This reduces the engine speed and removes the power from the motors.

2. Return Reverser Handle to Off Position.

When the locomotive has been brought to a stop, place the reverser handle in the middle or neutral position. Make this a habit. Do it every time the locomotive is stopped.

Stopping the Diesel Engines

1. Allow diesel engine to idle five minutes.

This permits the heat in the diesel engine to be dissipated, and prevents boiling of cooling water which would occur if diesel engine were shut down immediately after pulling a heavy load.

2. Pull out Engine-stop buttons.

This shuts off the fuel supply to the diesel engines. After diesel engines have come to rest, push Engine-stop button in as far as it will go.

Leaving the Locomotive

1. Stop engines.
2. Set hand brake.
3. Place reverse handle in neutral.
4. Close radiator shutters.
5. Close roof ventilating hatches.
6. Close compartment doors.
7. Open all light switches.
8. Open cab-heater switches.
9. Open control switch.
10. Open battery switch.
11. Close windows and doors.

Operation with Partial Equipment

This is only to be done as an emergency, and continued only long enough to get in the clear. If this is not done properly, the equipment will be seriously damaged.

1. Open cutout switch on faulty motor.

This will isolate a portion of the control circuits and keep power from the faulty motor.

2. Do not overload equipment still in service.

Observe the load carefully, by watching the load indicator, and keep load in safe zones. See following paragraph.

3. One motor cut out on four-motor locomotive--operate locomotive at one half load.

Remember that, with one motor operating alone on one power plant, this motor will be overloaded to the point of wheel slipping, while the two motors on the other power plant are operating at reduced adhesion. The load indicator either will not indicate at all or will not give a correct indication on the end operating with one motor cut out. Damage to equipment can occur unless the locomotive load is limited to approximately one half of that with four motors.

4. Do not operate locomotive with one or more motors cut out any longer than necessary.

If motors or power plant become disabled, only operate locomotive at reduced load with remaining equipment long enough to get in the clear.

Operating in Cold Weather

Ordinary cold weather will not cause any difficulty in starting or loss of efficiency, if the diesel engine is in good mechanical condition and the

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precautions necessary for cold-weather operation are taken.

Before attempting to start the diesel engine when the temperature is below 50 F, the water in the engine jacket should be warmed to 50 F or higher, in order to attain quick starting and to avoid exhausting the battery by excessive cranking. The kerosene water heater in each engine compartment is provided for this purpose.

To operate the heater, proceed as follows:

1. Open the shutoff valve (12, Fig. 5A) in the water-heater circuit. This valve should be closed at all times, except when the heater is operating.
2. Open the valve in the kerosene supply line to the heater. It is located just below the kerosene tank.
3. Fill the oil reservoir with a good grade of kerosene.
4. Raise drum by means of the drum handle in the slot below the feed line.
5. Turn the handwheel to the right, until the indicator pointer rests against the wick stop.
6. Light the wick in several places.
7. Lower drum gently in place, by lowering drum handle in slot.
8. Turn drum to the right and left with the handle on the side, to make certain it rests evenly on the wick tube flange.
9. From three to five minutes will be required for the flame to reach its complete height.
10. The high flame should be clear-blue in color, but when the burner has been operating at low and is turned to high, it will burn yellow for a short time.
11. Make sure that the safety-trip lever on the float chamber is in the down position. This lever should stay in the down position when the heater is operating.

To shut down the heater

1. Turn handwheel to the left as far as it will go.
2. When the flame has gone out, raise the drum by means of the drum handle.
3. Leave the drum in the raised position, as this prevents oil from creeping up on the combustion tube and causing an odor when the burner is again lighted.

HOW TO OPERATE THE LOCOMOTIVE

4. Close shutoff valve in water-heater circuit.
5. Close valve in kerosene supply line.

Towing the Locomotive

1. *Prepare locomotive as in "Leaving the Locomotive."* Refer to page 25 for details.

2. *Set dead-locomotive air-brake fixture.*

When the locomotive is to be hauled dead in the train, place the handle of the automatic-brake valve in Running position, close the double-heading cock under the brake valve, and open the dead-engine cock. The locomotive brakes will then operate like those of a car in the train.

If, for any reason, it is desirable to keep the maximum braking power of such a locomotive lower than the standard, this can be accomplished by reducing the adjustment of the safety valve on the distributing valve. It can also be reduced at will by the independent-brake valve.

3. *Remove traction-motor brushes.*

This is important if locomotive is to be towed more than 100 miles.

4. *Remove pinions on traction motors, if towing speed is to be more than 35 mph.*

This is necessary to protect the rotating parts of the motors against mechanical damage. For mounting and removal of pinions, refer to detailed instructions in locomotive-maintenance instruction book.

5. *Release hand brake.*

Derailment

Proceed as with all rerail jobs. The truck on the track can be used to rerail the locomotive. Cut out motors in the derailed truck, and slowly apply power to the truck on the track by steadily opening the throttle. Watch load indicator to prevent -damage to motors on live truck.

Section 3

Diesel Engines

General Description

The eight-cylinder, D17000 "Caterpillar" diesel engines which furnish the power to drive the locomotive are internal-combustion engines. They operate on the compression ignition principle, burning oil commercially known as diesel fuel without the assistance of spark plugs or externally heated surfaces. The engine piston displacement is 1662 cubic inches and the maximum speed is 1000 rpm, with an idling speed at 400-420 rpm. Each piston requires four strokes to complete the cycle of operation. The working process is as follows. See Fig. 9.

Stroke 1: As the piston moves down on the inlet stroke, air is drawn through the air cleaners, passes through the inlet valve into the main combustion chamber. The diesel engine always takes in a full charge of air on each inlet

stroke, whether operating at idling speed or full load.

Stroke 2: On the compression stroke, both the inlet and exhaust valves are closed, and the piston moves up, crowding the air within the cylinder into an extremely small space. When the piston reaches the top center, the air is compressed to 375 lb per sq in. This high compression causes the air to reach a temperature higher than 1000 F (338 C). When the fuel is sprayed into this highly heated air, it will ignite and burn readily. While the air is being compressed in the main cylinder, highly heated air currents pass into the precombustion chamber. This air is set aside to ignite the fuel.

Stroke 3: Near the end of the compression stroke, and at the beginning of the power stroke, the fuel pump forces a Measured quantity of fuel through the fuel line, into the fuel-injection valve, which sprays it into the precombustion chamber. This fine

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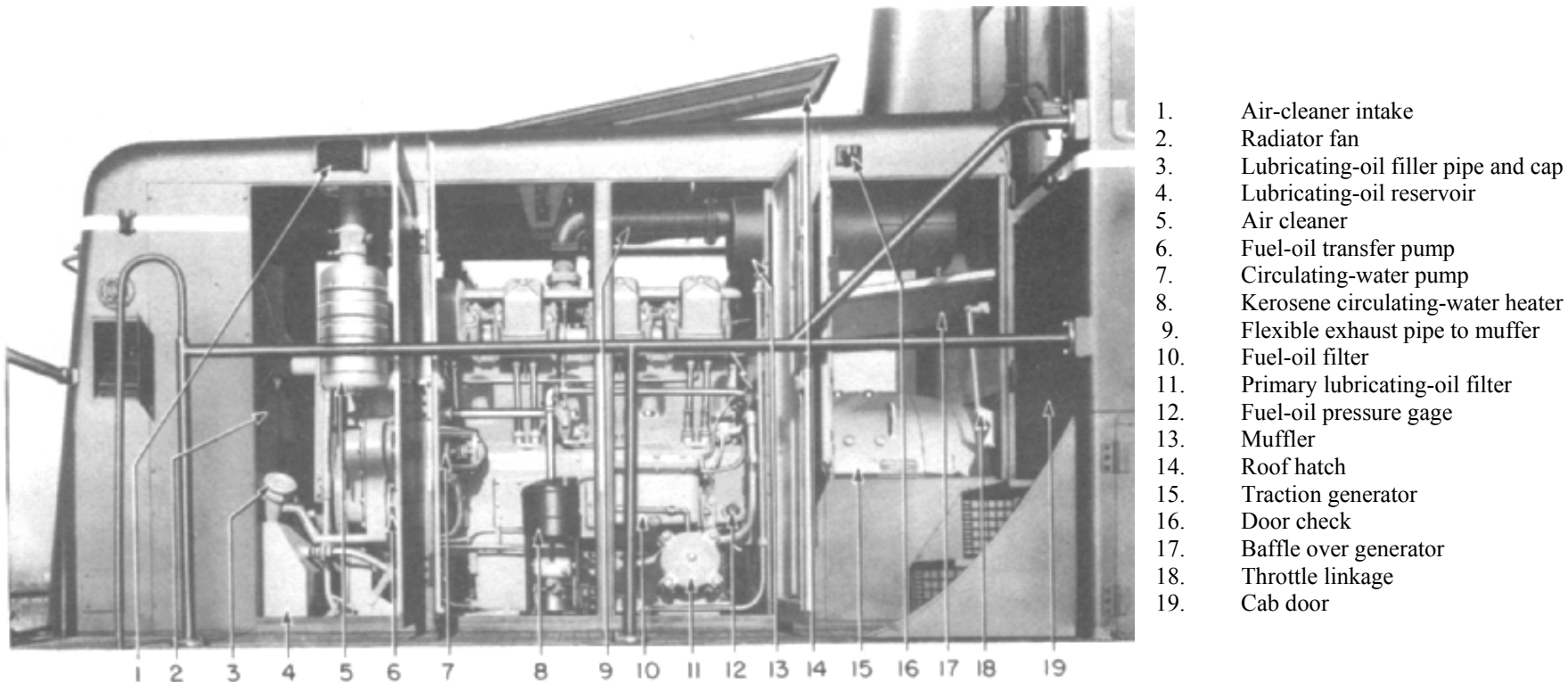


Fig. 7 - No 2 power plant, "A" side

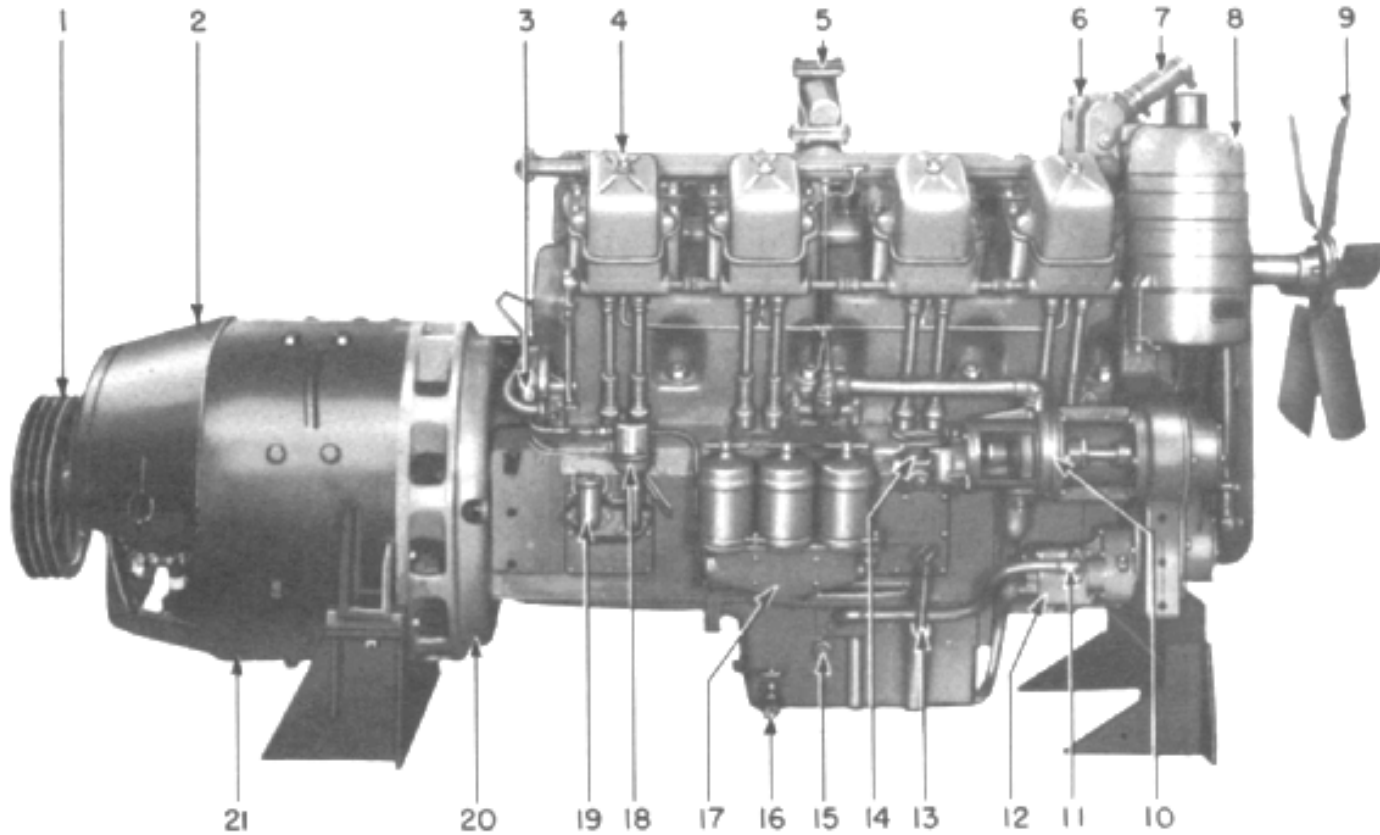


Fig. 8. Caterpillar diesel engine, 190 hp, with direct-connected G-B traction generator

- | | | | | | |
|----|---|-----|---------------------------------|-----|--|
| 1. | Pulley for driving auxiliary-generator exciter set and air compressor | 8. | Air cleaner | 18. | Lower sump drain |
| 2. | Commutator inspection cover | 9. | Radiator cooling fan | 17. | Secondary lubricating-oil filter |
| 3. | Compressor release lever | 10. | Cooling-water circulating pump | 18. | Crankcase breather |
| 4. | Cylinder-head cover | 11. | Lubricating-oil pressure pump | 19. | Crankcase-lubricating-oil filter opening |
| S. | Exhaust outlet | 12. | Lubricating-oil scavenging pump | 20. | Flywheel housing |
| 8. | Thermostat housing | 13. | Bayonet gage | 21. | Traction generator |
| 7. | Cooling-water discharge | 14. | Hour meter | | |
| | | 15. | Upper sump drain plug | | |

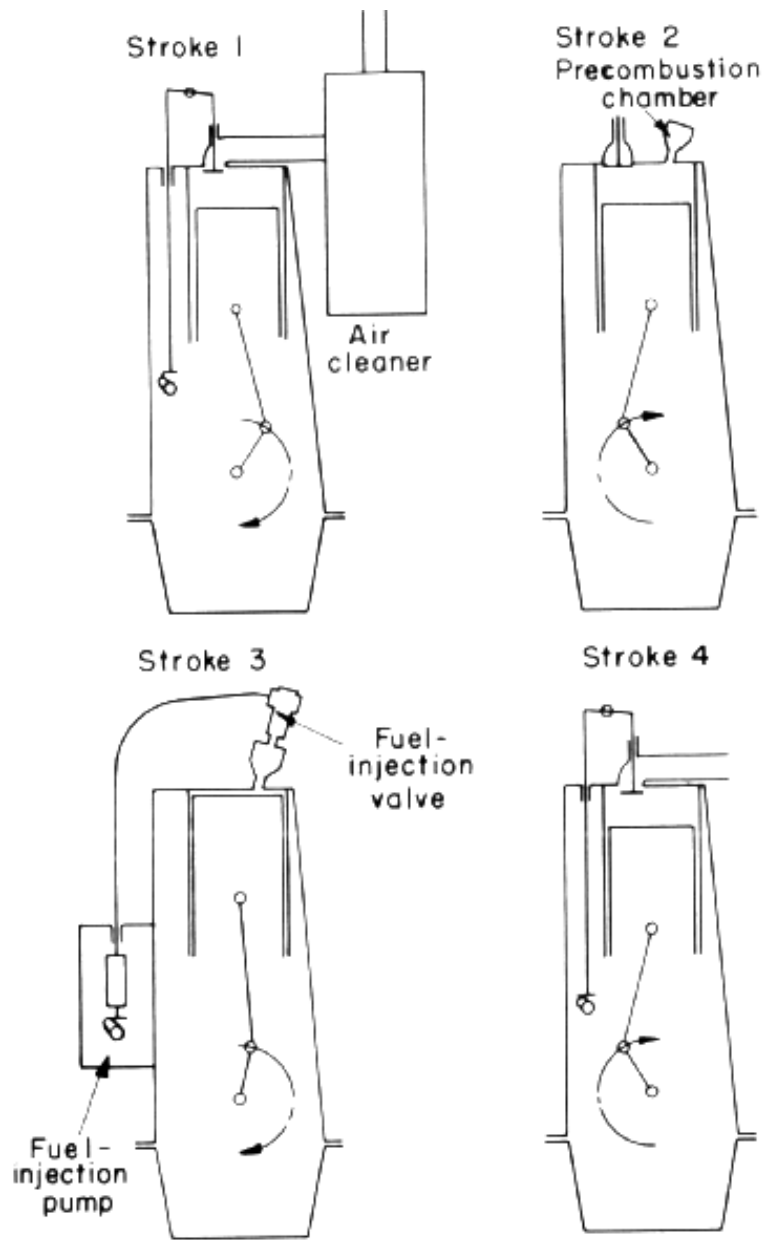


Fig. 9. Working process of diesel engine.

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spray heats quickly and ignites. As more fuel is injected, it is enveloped by flame, becomes gasified, and travels through the opening into the main combustion chamber, where additional air is available to complete its combustion. Power is thus obtained, and the piston is forced down by the pressure of the expanding and burning gas above it.

Stroke 4: As the piston moves up on the exhaust stroke, the exhaust valve opens, and the burned gases are forced out through the exhaust pipe.

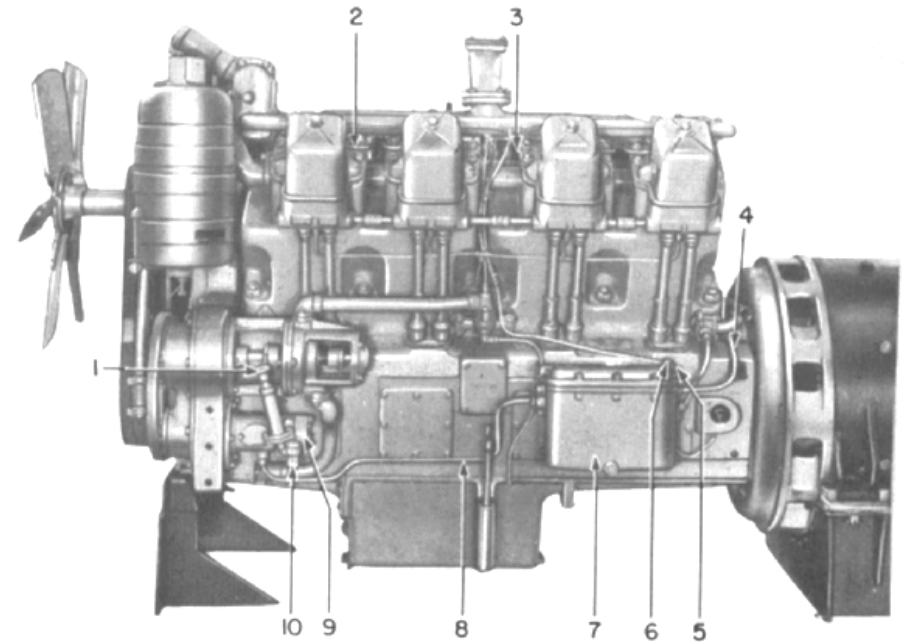
A smoky exhaust means inefficient engine output, indicating that fuel is passing through the engine without being burned. Continued operation under these conditions will finally gum the parts within the cylinders and cause excessive wear of cylinders, valves, and other parts. Never overload the engine.

Fuel-injection System

The gear-driven fuel-transfer pump draws fuel from the fuel tank and supplies it under pressure to the fuel filters, which remove dirt and other foreign material. The fuel then passes to the manifold for the individual fuel-injection pumps—one for each cylinder. These fuel-injection pumps measure the fuel according to engine load, and force the fuel through the fuel-injection lines to the injection valves in the cylinder head. The injection valves let the fuel into the precombustion chamber, where it is ignited and passes into the engine cylinder.

To prime the fuel system: Make sure the emergency fuel-shutoff valve is open. See that the fuel tank is full; open the fuel-filter vent valves. See Fig. 11. Unscrew the hand priming fuel-pump plunger, and operate with full and steady strokes. See Fig. 12. When the flow of fuel through the vents becomes continuous and contains no air bubbles, close the filter vents; then open each fuel-injection-pump vent in turn, continuing to operate the hand priming pump until each vent discharges solid fuel. Open and close the vents several times in succession, to be sure that all of the air is bled from the system.

DIESEL ENGINES



1. Hand priming pump
2. Fuel-injection lines
3. Fuel-injection pumps
4. Fuel line from filter to injection pumps
5. Fuel return line from by-pass valve to fuel tank is attached here
6. Fuel by-pass valve
7. Fuel filter
8. Fuel line from transfer pump filter
9. Fuel-transfer pump
10. Fuel inlet from tank

After the system is primed, the hand-priming-pump plunger should be forced to the bottom of the pump cylinder and screwed into place. This closes the valve seat located in the bottom of the cylinder which prevents air from leaking by the piston and the fuel-injection system.

Air Cleaners

Air cleaners are provided at the intake of the inlet manifolds,

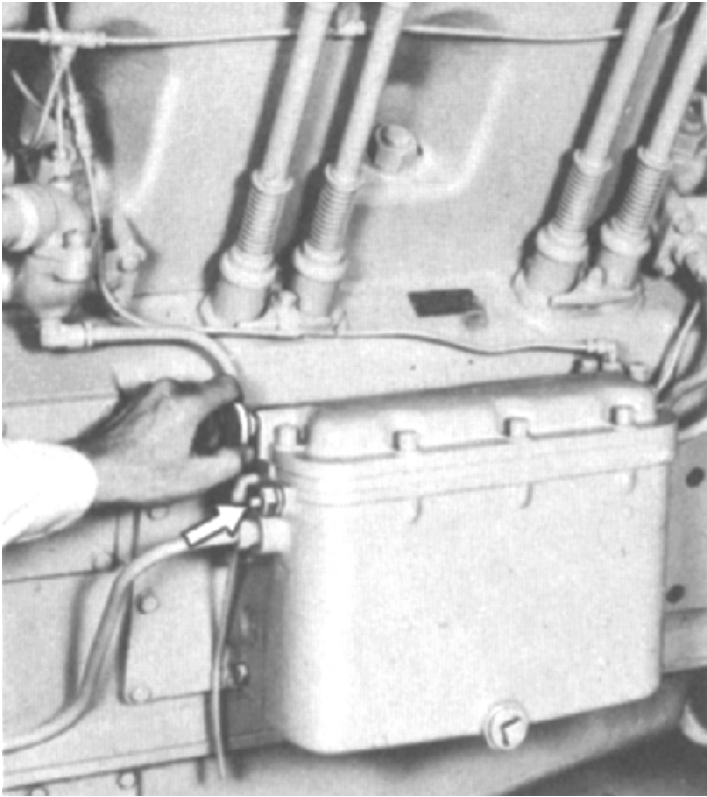


Fig.11 Opening fuel-filter vent valve

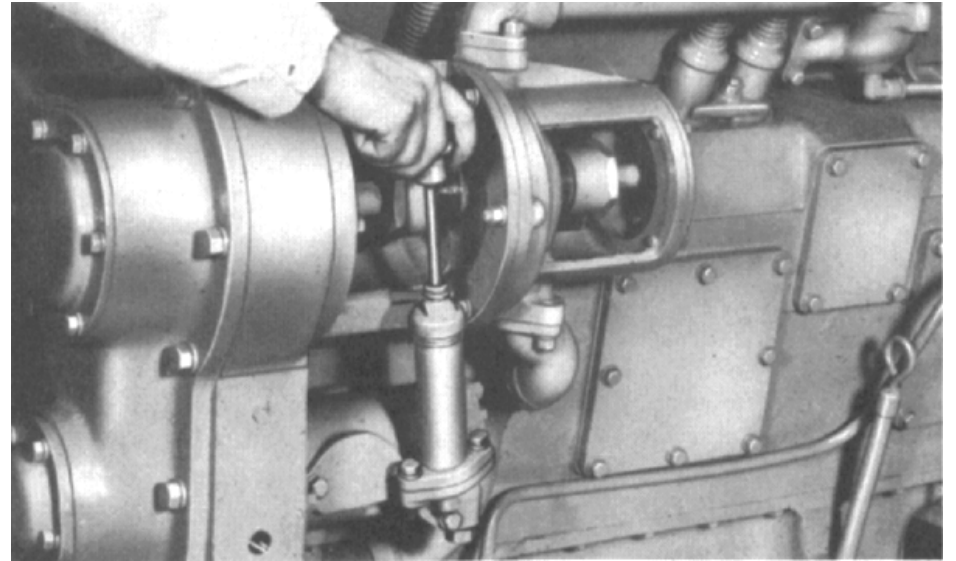
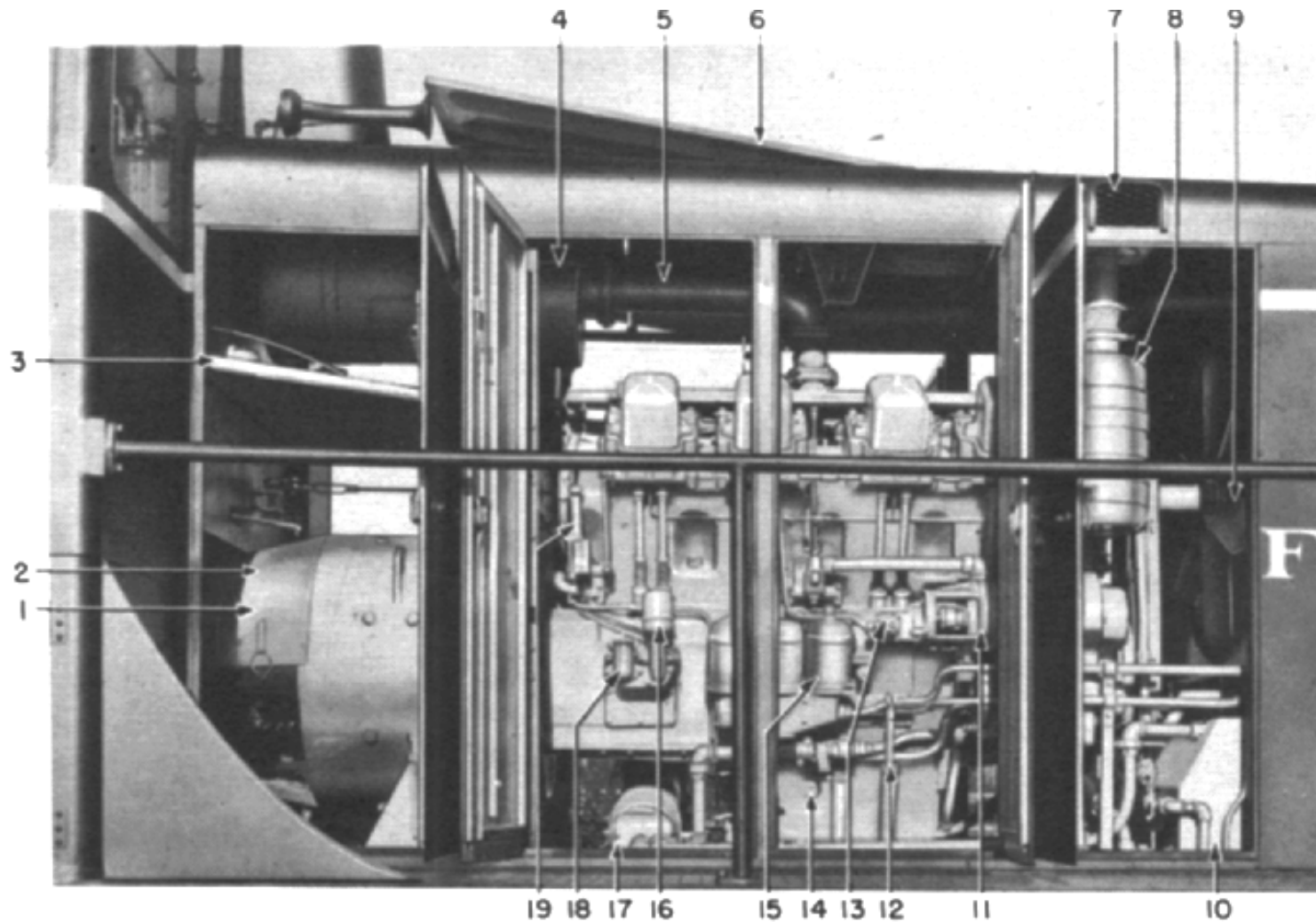


Fig. 12. Operating the priming pump



1. Generator commutator cover
2. Traction generator. Type GE-555-A
3. Baffle over generator
4. Muffler
5. Flexible exhaust pipe to muffler
6. Roof hatch
7. Air-cleaner intake

8. Air cleaner
9. Radiator cooling fan
10. Lubricating-oil reservoir
11. Cooling-water-circulating pump
12. Bayonet gage
13. Hour meter
14. Upper sump drain plug

15. Secondary lubricating-oil filter
18. Crankcase breather
17. Primary lubricating-oil filter
18. Crankcase lubricating-oil filler opening
19. Compression-release lever in Ran position

Fig. 13. No. 1 power plant, "A" side

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to prevent abrasive particles present in the air from being drawn into the engine cylinders, and causing excessive wear.

The air cleaner on a diesel engine will clean and pass a greater volume of air in a day's run than the air cleaner on a gasoline engine doing the same work under like conditions. Each diesel engine cylinder draws in a full charge of air on every inlet stroke, regardless of the engine speed or the amount of work the engine is doing.

The interval necessary between oil changes and cleaning will vary with the weather and the working conditions. During the hot dusty months, and on jobs where dust conditions are severe, it may be necessary to service the diesel-engine air cleaner every five hours. In cold, damp weather, and on jobs where there is little or no dust, this operation may be necessary only every 120 hours. However, dependence should not be placed on visible detection of dust, or lack of dust, in the air as a basis for servicing the air cleaner. The oil in the air cleaner may become saturated with dust, because of its fineness, much more rapidly than in instances where dust is more apparent.

The fine particles of dust become suspended in the oil, lowering its spray and cleaning efficiency, without leaving any noticeable sediment in the cup. Consequently, the best guide to follow in servicing the air cleaner is the appearance of the oil in the air cleaner, which will become increasingly cloudy,

Lubricating System

To prevent excessive wear, the moving parts of the engine must be effectively lubricated. The lubrication system supplies clean oil to bearings and other moving parts at all times when the engine is running. The pressure in this system is indicated by a gage on the instrument panel at the engineman's station. If the pressure fails, the engine should be shut down without delay.

The oil flows through the system in the following manner,
Fig. 14; Clean oil is, drawn from the supply tank 1, by the pressure pump 2,

DIESEL ENGINES

is forced to the coil cooler 8, then to the engine oil filters 4, on through the oil manifolds to the bearings and other parts of the engine. After it has lubricated the engine, the oil drops down into the upper sump 5 of the engine oil pan.

The oil overflows from this sump into the lower sump 6, where it is picked up by the scavenging pump 7, and is delivered to the absorbent filter 8, and thence to the supply tank 1, thus completing the cycle.

The oil pan has two sumps, the upper and lower. The upper sump 5 acts as a settling basin to trap condensate and other foreign material. The lower, or main, sump 6 receives oil through an overflow pipe in the upper sump. In this way, most of the oil is shielded from the heat and blow by gases from the engine, retarding oil deterioration.

The supply and scavenging pumps 2 and 7 are of the gear type. They form a single unit which mounts on the timing-gear housing and is gear-driven. Engine oil pressure is automatically maintained at approximately 30-35 lb by means of a by-pass valve in the oil distributing system. When the oil is cold, as may be the case during the first few minutes of operation, it is by-passed around the oil cooler to assure immediate lubrication to the engine.

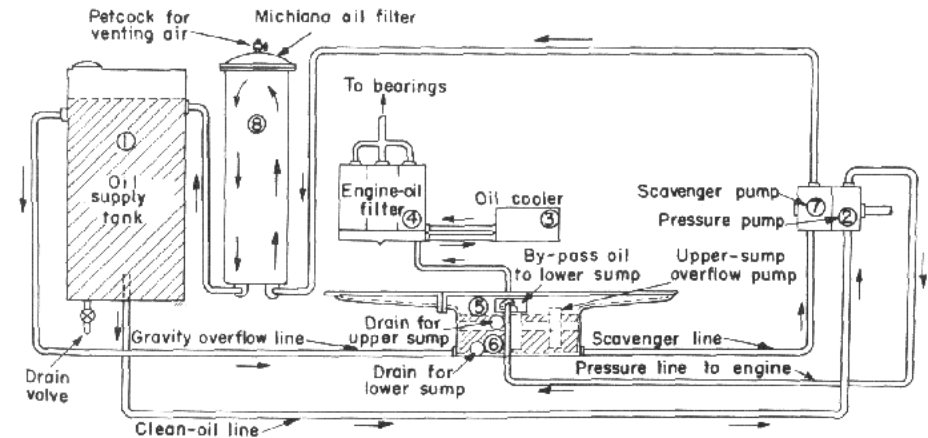


Fig. 14. Diesel-engine full-flow lubricating-oil system

Cooling System

In an internal-combustion engine, the burning of fuel in the cylinders generates more heat than can be converted into useful power. This excess heat is carried away by water, which circulates through cored passages in the cylinder walls and heads.

Water is drawn (Fig. 15) from the bottom header of the radiator by two pumps, one on each side of the engine, and delivered through manifolds to the cylinder jackets, and thence back to the radiator. In passing through the

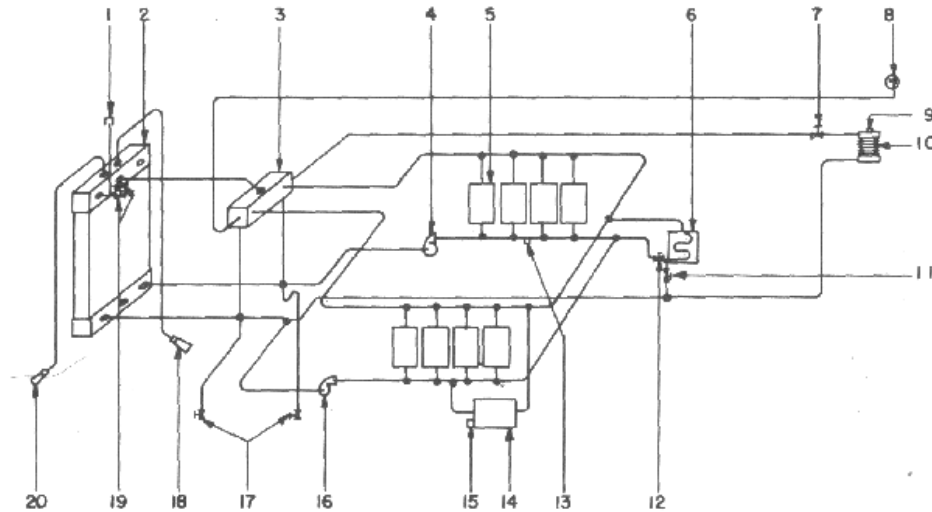


Fig. 15. Schematic water-piping diagram

- | | |
|---------------------------|------------------------------|
| 1. Antifreeze filler pipe | 11. Drain valve* |
| 2. Radiator | 12. Water-heater valvet |
| 3. Thermostat housing | 13. Drain plug |
| 4. Pump | 14. Fuel-filter water jacket |
| 5. Engine water jacket | 15. Drain plug |
| 6. Water heater | 16. Pump |
| 7. Cab-heater valve | 17. Drain valve* |
| 8. Temperature gage | 18. Radiator filler pipe |
| 9. Air vent | 19. Water-level try cocks |
| 10. Cab heater | 20. Radiator filler pipe |

* This valve must be opened when draining the system. Keep closed at all other times.
 + This valve must be opened when operating the kerosene water heater. Keep closed at all other times.

radiator, it is cooled, by the air drawn over the radiator tubes by the engine fan.

A thermostatic by-pass valve in the line from the engine to the radiator by-passes the radiator, and returns the water directly to the pump inlets until the water has reached a temperature of 165 F. This enables the engine to warm up quickly after starting, and maintain\$ an even temperature with varying loads.

A thermometer, located on the instrument panel at the engineman's position, indicates the temperature of the cooling water leaving the engine. Excessive temperatures (above 190 F) or abrupt changes ill temperature indicate trouble and should be investigated immediately. The engineman can control the water temperature by means of the radiator shutters and hatch cover opening. Best operation is obtained with temperatures between 160 and 180 F.

1. Cooling water.

Keep the system filled with clean water. Naturally, soft water, as free as possible from scale-forming minerals, is best.

If it is impossible to obtain soft water, treat the available water with some commercial water softener. Water should be heated in a clean tank or barrel, and allowed to stand before adding it to the engine cooling system. Do not add chemicals directly to the water in the cooling system. When this is done, insoluble compounds are sometimes formed which clog the small passages in the radiator and engine block.

When clean, naturally soft water is used in the cooling system, it is possible to operate for long periods without draining. However, when softened water is used, drain the system at frequent intervals to' remove sediment and prevent concentration of the softening chemicals. This should be done at the end of the day's work when all the material is in suspension and will drain with the liquid.

2. Antifreeze.

When the temperature is below freezing, use sufficient antifreeze to prevent freezing in the radiator and other exposed pipes.

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Commercial solutions are available for this purpose, or glycerine may be used. Alcohol can be used successfully, but because it readily evaporates at the normal operating temperature of the engine, which is approximately 170 F (77 C), any alcohol should be tested frequently--even daily--and kept up to correct strength.

3. *Drain the cooling system.*
 - (a) Open drain valves in lines from radiator to pumps (one on each side).
 - (b) Open drain valve in kerosene-heater circuit.
 - (c) Remove pipe plug in lower water manifold on right side of engine.
 - (d) Remove pipe plug on front end of fuel-filter housing on left side of engine.
 - (e) Open shutoff valves in the cab-heater circuit and the kerosene water-heater circuits, to prevent trapping water in these circuits.

Hour Meter

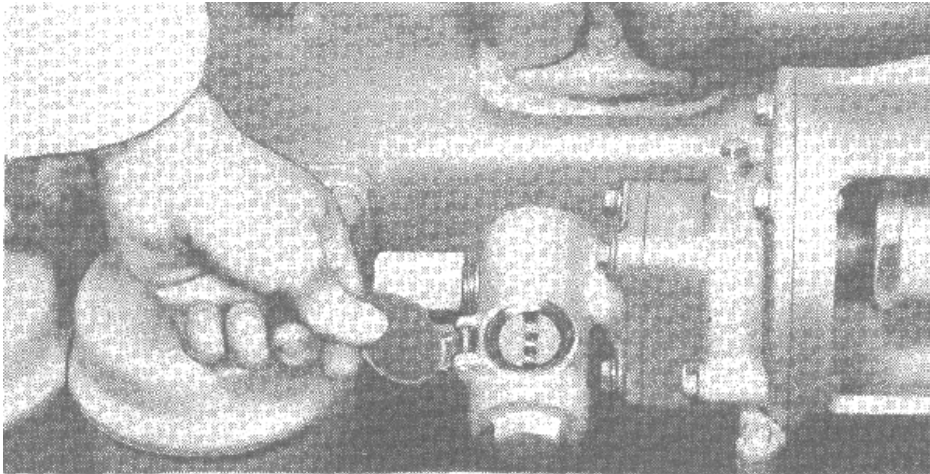


Fig. 16. Cover on hour meter raised to observe dial reading

DIESEL ENGINES

Your engine may be equipped with an "Hour Meter." It does not keep pace with the clock, but it does count and record the revolutions of the engine. See Fig. 16.

The dial advances one number each time the crankshaft has turned as many thousands of revolutions as are made in a clock hour at 850 rpm. Therefore, if the average engine operating speed is less than 850 rpm, the clock time necessary to record an hour-meter hour will be proportionately greater. The hour meter will prove valuable in determining lubricating and maintenance periods which are based on engine revolutions.

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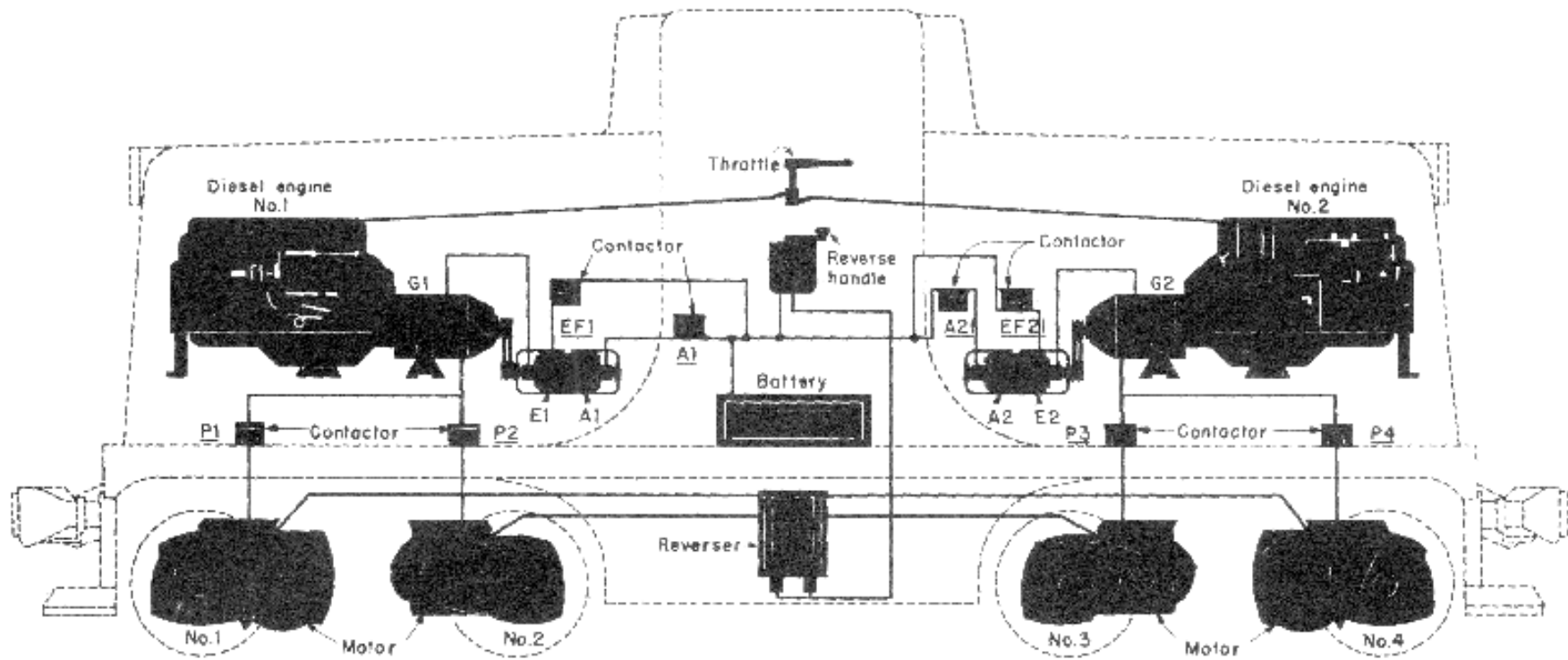


Fig. 17. Power plant's principal control and propulsion circuits

- | | | | | | |
|---------|----------------------------|----------------|------------------------------|---------|----------------------------|
| G1 | Main generator | P1, P2 | Traction-motor contactors | A21 | Battery-charging contactor |
| A1 | Auxiliary generator | Throttle | | EF21 | Exciter field contactor |
| E1 | Exciter | Reverse handle | Battery | No. 3 } | |
| A1 | Battery-charging contactor | - - | Reverser for traction motors | No. 4 } | Traction motors |
| EF1 | Exciter field contactor | G2 | Main generator | P3, P4 | Traction-motor contactors |
| No. 1 } | Traction motors | A2 | Auxiliary generator | | |
| No. 2 } | | E2 | Exciter | | |

Section 4

Electric System

General Description

The electric system is divided according to function into three principal groups, namely

1. *The Electric-drive Equipment.*

This transmits the power from the diesel engine to the locomotive wheels, and provides an automatic variable-speed ratio between engine revolutions and axle revolutions. The full power of the engines can thus be used over a wide range of locomotive speeds. The equipment consists of the traction generators and their exciters, the traction motors, and the contactors, reverser, relays, and switches which control their operation..

2. *The Engine-starting Equipment.*

This cranks the engines to start them. It consists of the storage battery, the traction generators which are equipped with special windings to enable them to be used as cranking motors, and the push-button switches and contactors to connect them to the battery.

3. *The Auxiliary-power Equipment.*

This provides current at approximately 75 volts for charging the storage battery, and for operating contactors, lights, and cab-heater fans. It consists of the auxiliary generators, the relays and contactors which automatically control them, and the manually operated switches for the lights and heater fans.

The operation of the electric system is easily understood if a few simple rules are followed.

FIRST, learn the function of the machines and devices. The table of electric equipment on page 45 gives the function of each device. It also shows the symbol by which it is indicated on the circuit diagrams.

SECOND, study circuit diagrams to find out how and when each device operates and what it accomplishes.

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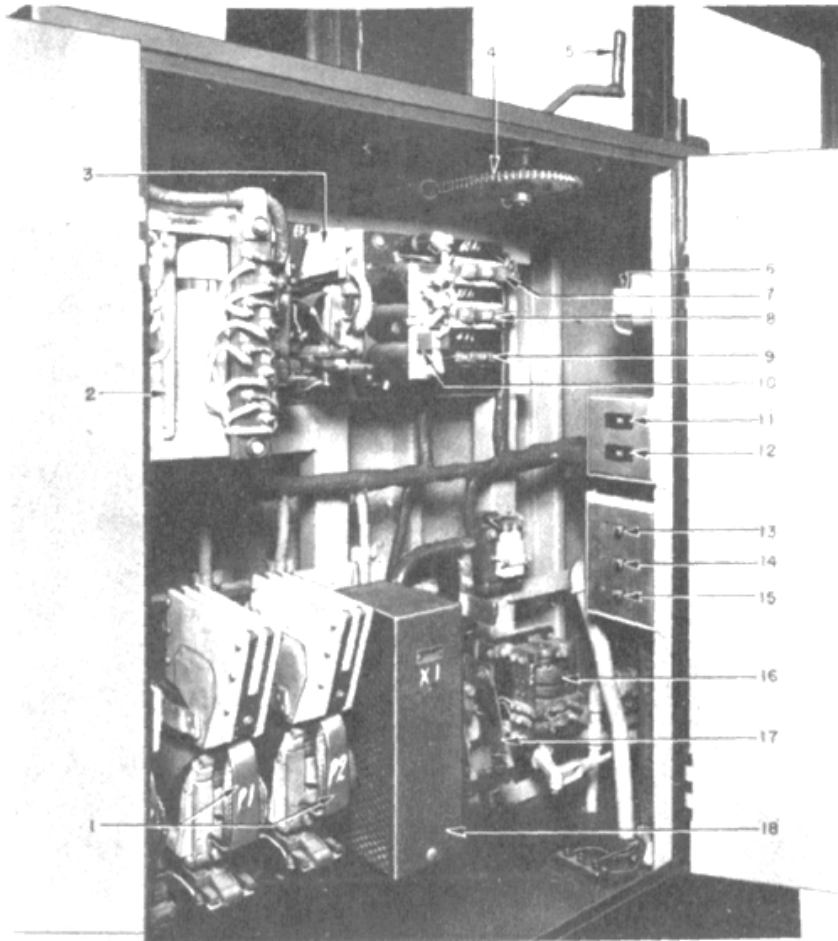


Fig. 18. Interior forward control compartment, looking towards front of locomotive

- | | |
|---|--|
| 1. Motor line contactors. P1 and PE | 9. 4-ampere fuse for auxiliary-generator field circuit |
| 2. Control resistors, BR1, EFR1, HR1, HR2, and HFR | 10. Reverse-current relay, RCI |
| 3. Exciter field contactor, EFI | 11. Control circuit breaker |
| 4. Sprocket and chain for raising or lowering hatch cover | 12. Auxiliary circuit breaker |
| 5. Handle for raising or lowering hatch cover | 13. Exciter field cutout switch No. 1 |
| 8. Gage-panel lamp socket | 14. Traction-motor cutout switch No. 1, C01 |
| 7. 60-ampere fuse for battery circuit | 15. Traction-motor cutout switch No. I, C01 |
| 8. 35-ampere fuse for auxiliary-generator circuit | 18. Throttle control switch. TC |
| | 17. Battery switch, DS |
| | 18. Voltage-regulating relay, X1 |

ELECTRIC SYSTEM

Table of Electric Equipment

SYMBOL	DEVICE	FUNCTION
Generators and Motors		
G1, G2	Traction-generator armatures	Furnish power for traction motors
1, 2, 3, 4	Traction-motor armatures	Locomotive driving motors
E1, E2	Exciter-generator armatures	Furnish traction-generator field excitation
A1, A2	Auxiliary-generator armatures	Furnish power for battery charging, lights, and control
GF1, GF2	Traction-generator fields	Shunt fields of G1, G2
GS1, GS2	Traction-generator start fields	Series fields of G1, G2 when they are operated as motors for engine cranking
1, 2, 3, 4	Traction-motor fields	Series fields of 1, 2, 3, 4
EF1, EF2	Exciter-generator fields	Shunt fields of E1, E2
AF1, AF2	Auxiliary-generator fields	Shunt fields of A1, A2
Switches		
DS	Dp-st knife switch	Disconnects the battery from all circuits
Control	Dp-st tumbler switch	Disconnects control circuits from A1, A2, and battery
C01, C02 C03, C04	Dp-st tumbler switch	Disconnects motor contactors for cutting motors out of circuit
Light and Accessory	Dp-st tumbler switch	Used in separate lighting and accessory circuits for operation
Controller	Master controller	Completes circuits for reverser operating coils and determines direction of locomotive motion
Diesel-engine Start	Push-button spring-return switch	Starts diesel engines
TC	Throttle control	Controls motor-circuit contactors

Table continued on page 47

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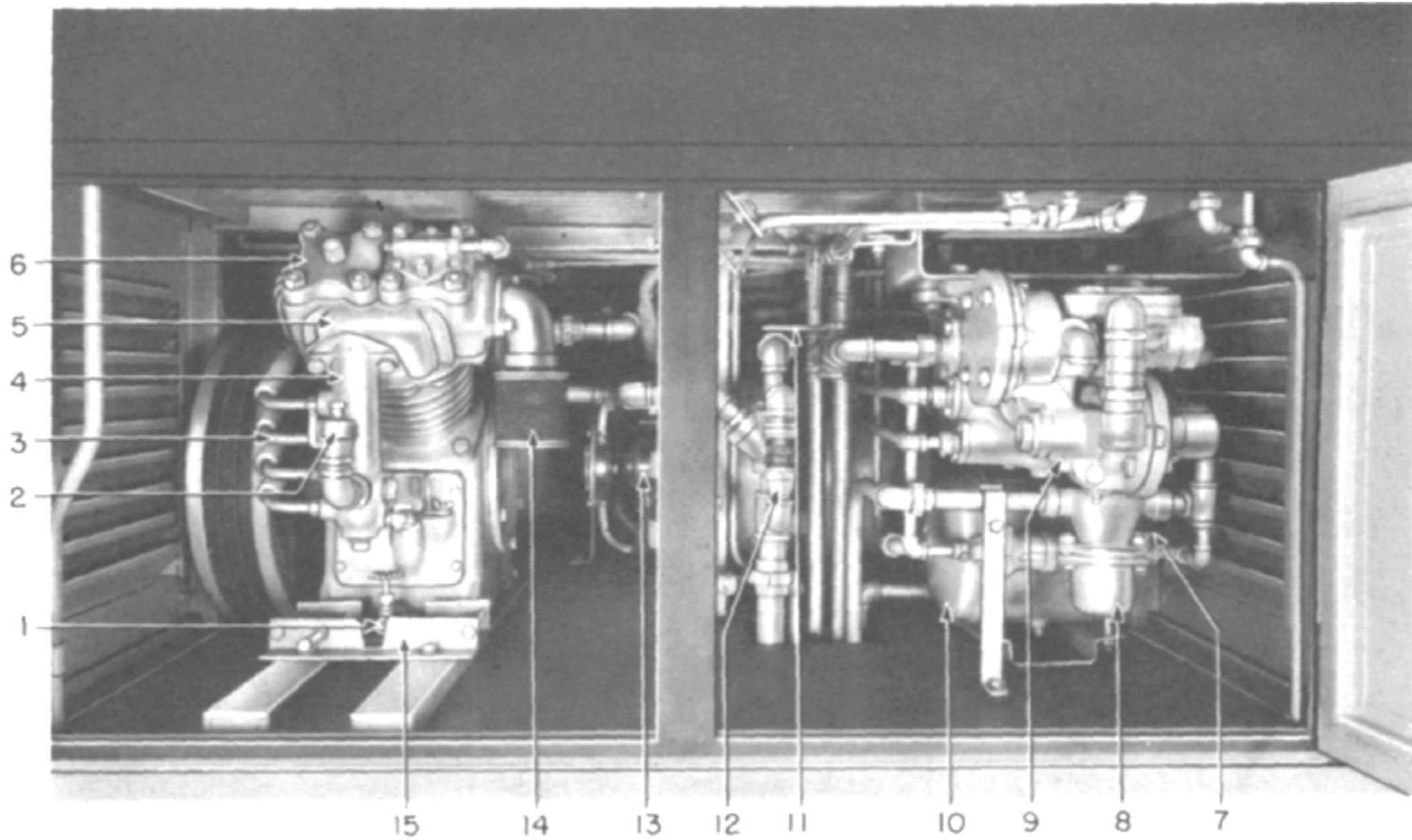


Fig. 19. Auxiliary-apparatus compartment. "A" side

- | | | |
|---|---|--|
| 1. Drain valve for air-compressor crankcase | 6. Valve covers (the above parts are all for Gardner-Denver air com. pressor) | 11. Distributing-valve cutout cock |
| 2. Compressor intercooler safety valve | 7. Dead-engine cutout cock | 12. Main-reservoir safety valve |
| 3. Intercooler for air compressor | 8. Dirt collector | 13. Auxiliary generator exciter set No. 1 |
| 4. Intercooler manifold | 9. Distributing valve | 14. Air filter for air-compressor intake |
| 5. Air-compressor cylinder head | 10. Equalizing reservoir | 15. Adjustable sub-base for air compressor |

ELECTRIC SYSTEM

Table of Electric Equipment (Cont.)

SYMBOL	DEVICE	FUNCTION
Contactors		
GS1, GS21	Diesel-engine starting contactors	Connect generators G1, G2 to battery for cranking diesel engine
P1, P2, P3, P4	Motor contactors	Connect generators G1, G2 to motors No. 1, 2, 3, and 4
M1, M2, M3, M4	Field-shunting contactors	Connect field-shunting resistors in parallel with fields No. 1, 2, 3, and 4
A1, A21	Auxiliary-generator contactor	Connects auxiliary generators A1, A2 to control circuits and battery for charging
EF1, EF21	Exciter field contactor	Connects positive of battery circuit to exciter-generator fields EF1, EF2
Reverser		
- -	Reverser	Reverses the direction of current flow in motor fields No. 1, 2, 3, and 4, thus reversing direction of rotation of traction motors
Coils	Reverser operating coils	Operate magnet valves which admit air to air engines for operating reverser
Interlock	Reverser interlock	Prevents motor line contactors closing, unless position of reverser corresponds to position of master controller
Relays		
FS	Field-shunting relay	Operates field-shunting contactors M1, M2, M3, and M4
CR	Field-shunting drop-out relay	Prevents operation of the traction-motor field-shunting connection above maximum permissible locomotive speed

Table continued on page 49

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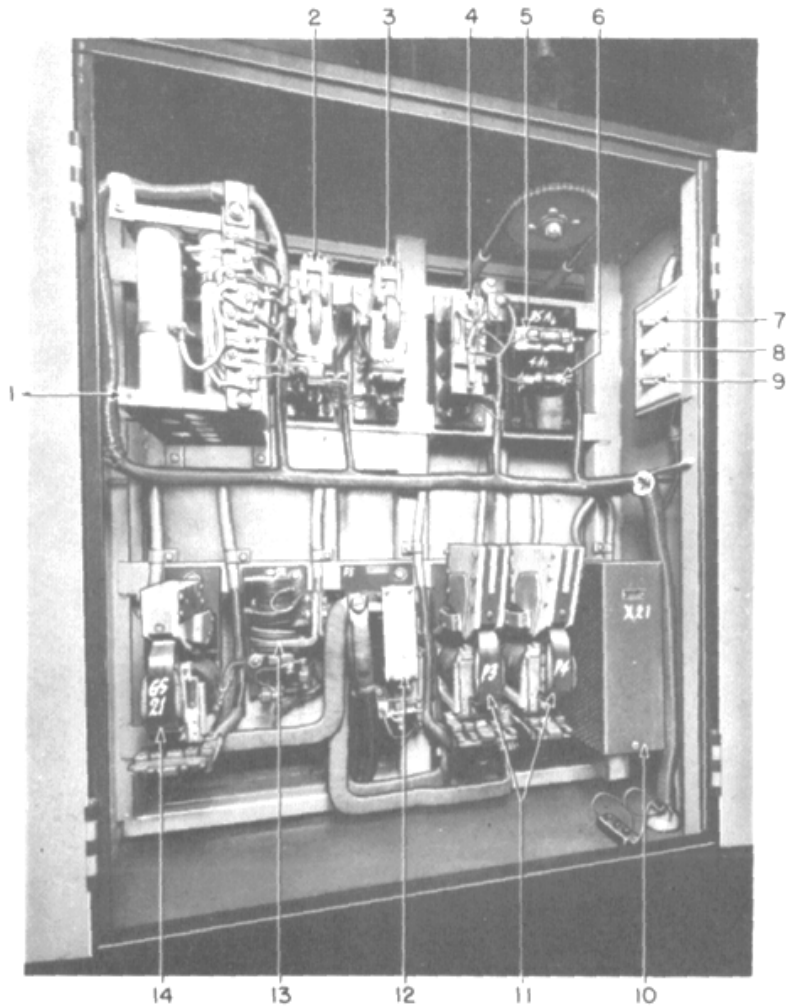


Fig. 20. Interior of rear control compartment, looking towards rear of locomotive

- | | |
|---|---|
| 1. Control resistors, BR21, EFR21, and EGR | 8. Traction-motor cutout switch. No. 3. C03 |
| 2. Auxiliary-generator contactor. A21 | 9. Traction-motor cutout switch. No. 4. C04 |
| 3. Exciter field contactor, EFRI | 10. Voltage-regulating relay, X21 for contactors. No. 2 |
| 4. Reverse-current relay. RC21 | 11. Motor line contactor, P3 and P4 |
| 5. 35-ampere fuse in auxiliary-generator | 12. Field-shunting relay, F5 |
| 6. 4-ampere fuse in auxiliary-generator field circuit | 13. Field-shunting drop-out relay. CR |
| 7. Exciter field cutout switch, No. R | 14. Engine-starting contactor, GS21 |

ELECTRIC SYSTEM

Table of Electric Equipment (Cont.)

SYMBOL	DEVICE	FUNCTION
Relays (Coat.)		
RC1, RCU	Reverse-current relay	Controls auxiliary-generator contactors A1, At and prevents battery current from operating auxiliary generator as a motor
XI, X21	Voltage-regulating	Maintains constant voltage outrelayout of auxiliary generators A1, At throughout their normal speed range

Control-circuit Resistors

BRI, BR21	Battery resistors	Limiting resistor for battery charging
EFRI, EFR21	Exciter field resistors	Control exciter field excitation
HRI, HR2	Headlight resistors	Connected in series with headlight and accessory circuits
HFR	Heater fan-motor resistor	Connected in series with fan motor
EGR	Electric indicator resistor	Used as potentiometers for electric indicators

FUSES AND CIRCUIT BREAKERS

Circuit	Volts	Amp	Quantity	Cat. No.
Fuses				
Battery.....	250	60	1	GE 1472
Auxiliary-generator.....	250	35	2	GE 1467
Auxiliary-generator-field...	250	4	2	GE 1455
Circuit Breakers				
Control and auxiliary. . . .	125	15	2	1GB115

Generators and Motors

1. Traction Motors.

The traction motors are direct-current, commutating-pole motors, direct-connected to double-reduction gear units.

The double-reduction gear unit contains both high- and lowspeed reduction gears. The gear box and gear cover, when bolted together, form an

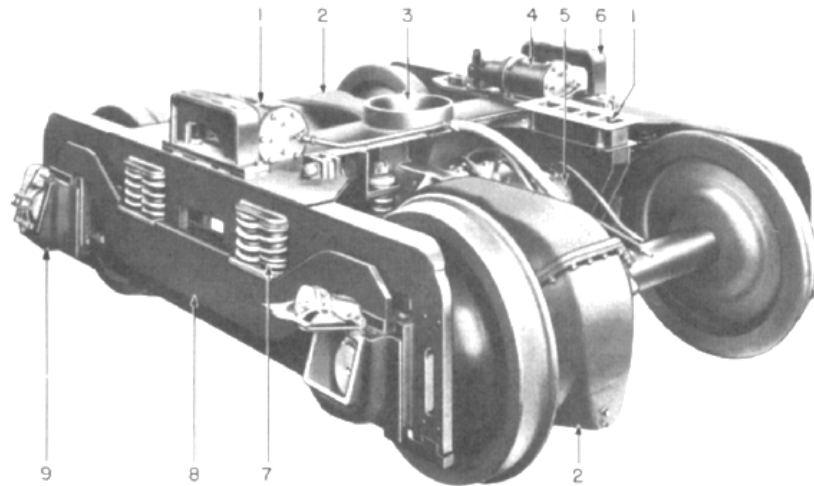


Fig. 21. Truck with traction motors

- | | |
|---------------------------------------|--------------------|
| 1. Traction-motor air-duct connection | 6. Side bearing |
| 2. Traction-motor gear unit | 7. Snubber springs |
| 3. Center plate | 8. Equalizer bar |
| 4. Air-brake cylinder | 9. Journal box |
| 5. Traction motor | |

oil-tight assembly to hold the oil which is used for both gear and bearing lubrication. The gear teeth are lubricated by dip and splash in the oil bath. Both the antifriction bearings and axle sleeve bearings are lubricated by splash from the gear train. It is essential that the proper oil level be maintained in the gear box at all times.

2. *Traction Generator.*

The traction generator (Fig. 22) is a direct-current, commutating-pole generator with a series field for starting. Its armature is connected to the diesel engine by means of a flexible coupling. It has a single exciting-field winding, separately excited from a splitpole exciter, which gives correctly proportioned excitation at various loads, thereby matching the engine output at all throttle positions

ELECTRIC SYSTEM

3. *Auxiliary-generator Exciter Set.*

The auxiliary-generator exciter set (Fig. 23) is essentially two separate electric machines, meochanically built into the same frame, with both armatures mounted on the one shaft. The unit is belt-driven from a pulley mounted on the generator shaft extension.

The auxiliary generator cfiarges the battery and supplies power for the control and light circuits. The exciter is designed and adjusted to furnish excitation for its traction generator.

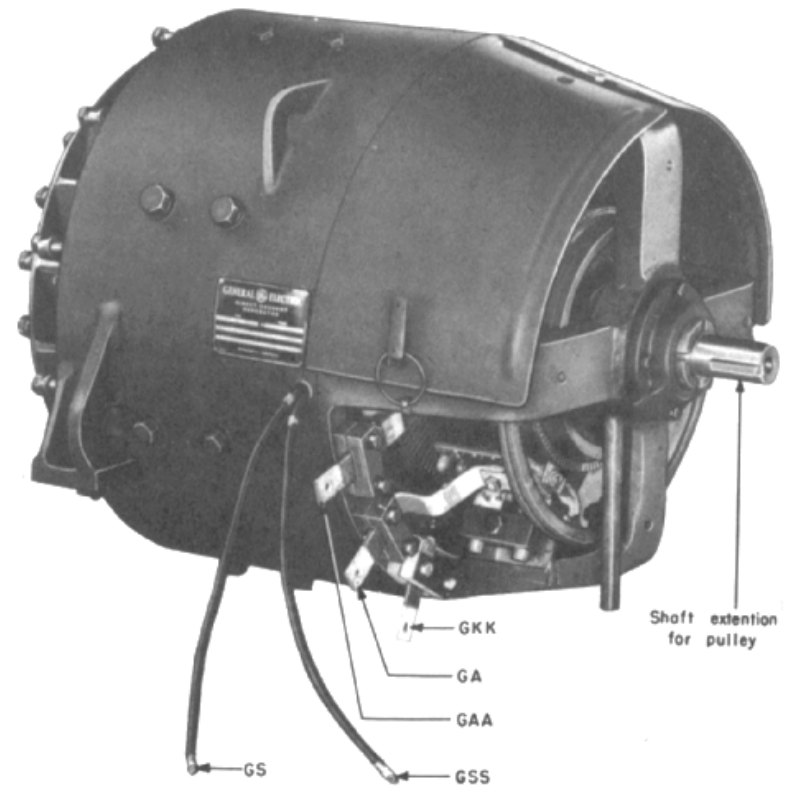


Fig. 22. Direct-current traction generator

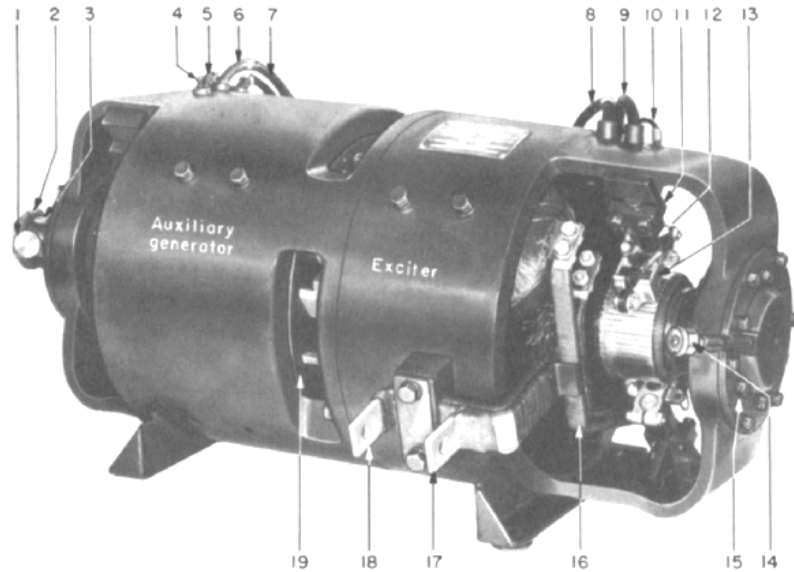


Fig. 23. Direct-current auxiliary-generator-exciter set

- | | |
|---|--|
| 1. Pulley-end bearing grease cup | 10. ES lead -exciter shunt-field terminal |
| 2. Pinion retaining nut and washer | 11. Brush-holder support |
| 3. Shaft extension with key | 12. Brush-holder stud |
| 4. I.SS lead--auxiliary-generator field terminal | 13. Brush holder |
| 5. I.S lead--auxiliary-generator field terminal | 14. Exciter-end bearing grease cup |
| 8. LAA lead-auxiliary-generator armature terminal | 15. Exciter-end bearing cap |
| 7. LA lead--auxiliary-generator armature terminal | 16. Exciter differential-field connecting strips |
| 8. EAA lead- -exciter armature terminal | 17. EF lead-exciter differential-field terminal |
| 9. EA lead--exciter armature terminal | 18. EFF lead-exciter differential-field terminal |
| | 19. Ventilating fan |

4. Inspection.

The engineman should be familiar with the appearance of all equipment, so that he can detect and report symptoms of failure.

- (a) Keep equipment clean at all times.
- (b) Check for loose electric connections.

- (c) Check commutators for roughness, burned or pitted segments, and eccentricity.
- (d) Check brushes for wear and stickiness in brush holders, and pigtails of brushes for short circuits and grounds.
- (e) Lubricate as outlined in Lubrication Recommendations, Section 7.

5. Troubles.

Trouble is usually detected by the presence of excessive heat or odor of burning insulation caused by:

- (a) Overloads.
- (b) Short-circuited armature or field coils.
- (c) Grounded armature or field coils.
- (d) Bad commutation, indicated by brush sparking.
- (e) Loose connections.
- (f) Incorrect connections.

Any of the above indicate trouble or future trouble, and should be reported to the maintenance crew at once. See Suggested Daily Report Sheet for use of engineman; page 93.

Storage Battery

The storage battery is of the lead-acid type, and consists of 32 cells connected in series.

The charging rate furnished by the auxiliary generators must be sufficient to take care of cranking the engines and stand-by lighting. Otherwise, the battery will soon become discharged and will not be able to start the engine. Conversely, if the charging rate is too great, the battery will overheat, the water in the electrolyte will gas off, and the plates will become warped.

The level of the electrolyte should never be allowed to fall below the top of the plates. Neither should it be carried so high that it overflows through the vent. If either of these conditions are observed, they should be reported to the maintenance crew.

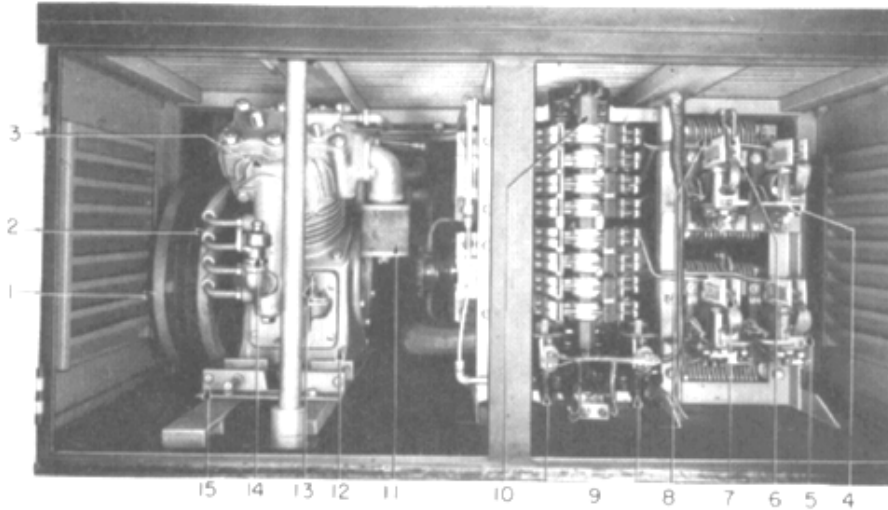


Fig. 24A Auxiliary-apparatus compartment, "B" side

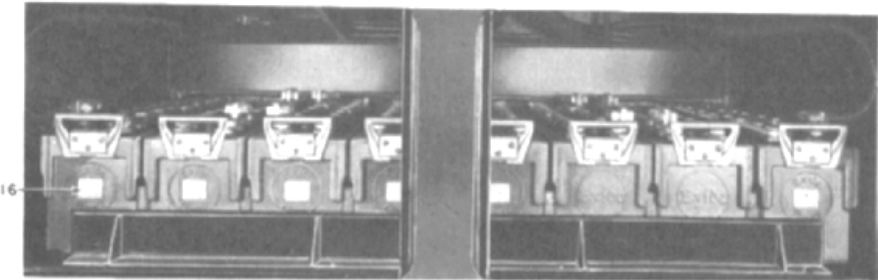


Fig. 24B. Storage-battery compartment, "B" side

- | | |
|-----------------------------------|---|
| 1. Air-compressor pulley | 10. Reverser cylinder |
| 2. Intercooler for air compressor | 11. Air filter for air-compressor intake |
| 3. Air-compressor cylinder head | 12. Air-compressor crankcase |
| 4. Field-shunting contactor. M2 | 13. Bayonet gage |
| 5. Field-shunting contactor. M4 | 14. Compressor-intercooler safety valve |
| 8. Field-shunting contactor, MI | 15. Adjustable subbase for air compressor |
| 7. Field-shunting contactor. M3 | 16. Storage battery |
| 8. Field-shunting resistor, FSR | |
| 9. Reverser magnet valves | |

A battery indicator on the instrument panel shows the charging conditions. These are as follows:

- a. When the pointer is in the first long red band, the battery is in poor condition or being discharged.
- b. When the battery is neither receiving charge nor being discharged, the pointer should be in the white band.
- c. When the pointer is in the green band, the battery is receiving a normal charge. The pointer may be in the white band below the green band just after starting the engines.
- d. When the pointer is in the small red band beyond the green band, the battery is being overcharged. Indications in either of the red bands for any length of time should be reported to the maintenance crew.

Control System

Fundamental schematic circuit diagrams are used to show how each function of the control system is actuated. On these schematic diagrams, each circuit can be traced by following the explanation and remembering that only the parts of a control device necessary for the particular function of the circuit are included. Also, normally closed contacts are assumed to remain closed when the operating coil is not shown.

All switches and the controller are shown in the Open, or Off, position, and the reverser is shown in the Forward position. All contactors, interlocks, and relay contacts are shown in the deenergized position with all operating coils de-energized.

Symbols on the diagrams denoting control devices with current-carrying contacts are underlined. For example, the auxiliary generator contactor, A1, is underlined, but the same symbol, A1, referring to the auxiliary generator is not underlined.

Symbol markings on the schematic connection diagrams may be identified by referring to pages 45, 47, and 49.

The diagrams themselves follow on pages 56 to 67.

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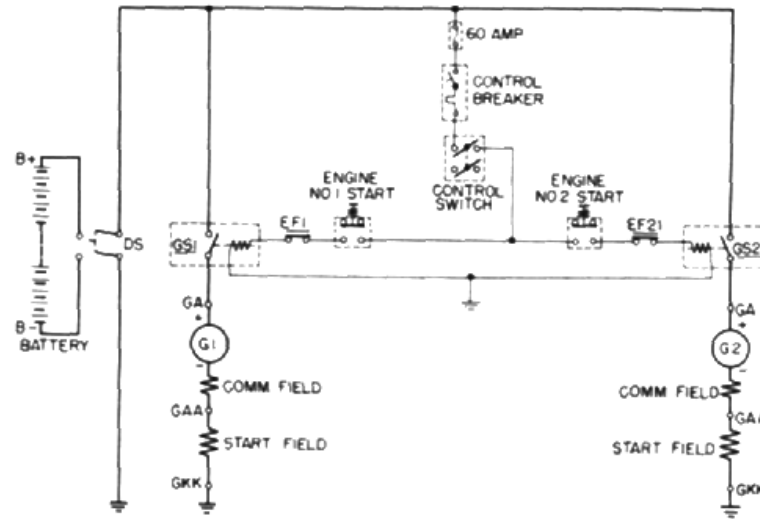


Fig. 25. Cranking circuits, Schematic No 1

Engine-cranking Circuits

The battery furnishes power for operating the main generator as a motor, thus cranking the engine.

The battery is connected to the main generator when the following sequence is completed.

1. Battery switch DS is closed manually.
2. Control breaker is closed manually.
3. Control switch is closed manually.
4. Exciter field contactors EFI (EF21) remain open.
5. Engine-start switches are closed manually.
6. Contacts of starting contactors GS1 (GS21) close and connect the battery to the main generators G1 (G2).
7. Generator armature and starting field are energized, and engine cranking commences.

Possible Causes of Trouble

If contactors GS1 (GS21) do not close, check for:

1. Open-circuited or grounded contactor coil.
2. Loose connection in the control or power circuits.
3. Poor contact in engine-start button.
4. Poor contact in normally closed interlock on EFI (EF21).
5. Tripped control breaker.
6. Poor connection and contact in control switch.

If contactors GS1 (GS21) close but engine does not turn over, check for:

1. Poor contacts GS1 (GS21).
2. Open-circuited or grounded generator armature.
3. Poor ground connection on battery, generator, or both.
4. Run-down battery.

Battery-charging Circuits

The battery is charged by receiving power from the armature of auxiliary generator A1 (A2). The battery is connected to the auxiliary generator after the following sequence has been completed

1. Battery switch DS is closed manually.
2. Control breaker is closed manually.
3. Control switch is closed manually.
4. Engine-start switches are open.
5. Engine-starting contactor GSI (GS21) remains open.
6. Relay RCI (RC21) closes.
7. When contacts of RCI (RC21) close, the auxiliary-generator contactors A1 (A21) close, connecting the auxiliary generators to the battery.
8. Battery is on charge. The polarity of the shunt and differential coils of the relay RCI (RC21) are so arranged that when the auxiliary-generator voltage is less than the battery voltage (a condition which would cause the auxiliary generator to run as a motor from the battery), the contacts of the relay are sealed in the open position. When the auxiliary-generator voltage is greater than the battery voltage (a condition satisfactory for battery charging), the relay closes. The series coil of this relay aids in keeping the relay closed when current flow is from the auxiliary generator to the battery, and opens the relay when sufficient current flows from the battery to the auxiliary generator, thus affording reverse-current protection.

9. Voltage regulator xl (X21) maintains constant voltage output of auxiliary generator A1 (A2) throughout its speed range. This is accomplished by the opening and closing of the contacts which connect various external-resistor arrangements in the auxiliary-generator field. The relay shunt coil is connected across the auxiliary-generator armature through resistor R4, and controls the contact operation. The compensating coil and resistor R6 aid in maintaining a steady voltage condition. When both auxiliary generators are charging the battery, the two regulator bias coils are connected in series by means of interlocks on contactors A1 and A21. If one generator delivers more than its share of charging current, the bias coils tend to balance the current between the generators by slightly increasing the voltage of one generator and decreasing the voltage of the other generator.

Possible Causes of Trouble

To check the battery-charging operation with both engines shut down, close battery switch DS. The battery voltmeter should read approximately 60 to 67 volts. If there is no voltage, inspect for a blown 60-amp battery fuse or poor connection in the battery or voltmeter circuits.

With one or both auxiliary generators running, battery charging should take place. This is indicated by an increase in voltage reading to approximately 70 to 74 volts, depending upon the condition of the battery.

Check charging of each auxiliary generator separately with the other generator shut down. If either auxiliary generator fails to charge, or if the voltage is not constant as indicated by fluctuations of the battery voltmeter, check for:

1. Blown 35-amp auxiliary-generator fuse, 4-amp voltage-regulator fuse, or tripped control circuit breaker.
2. Loose or open connections.
3. Poor contacts in control switches, interlocks, contactors, reverse-current relays, or regulator. Clean contacts with a cloth (do not use abrasive paper or a file).
4. Open-circuited or grounded wires or coils.
5. With battery switch open, operate contactor, relays, and regulators by hand for free action.
6. If RC1 (RC21) do not close, check voltage of auxiliary generator, since it has to be greater than battery voltage before the relay will operate. This trouble may be because of an internal failure of the auxiliary generator or voltage regulator XI (X21).

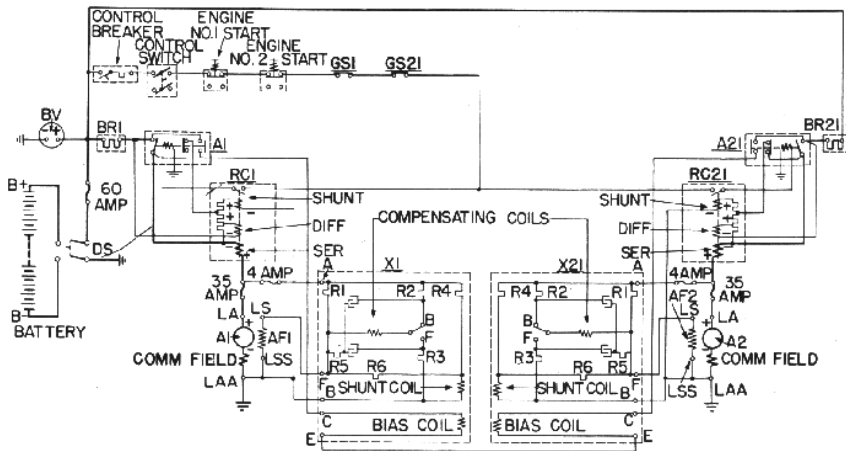


Fig. 26. Battery-charging circuits, Schematic No. 2

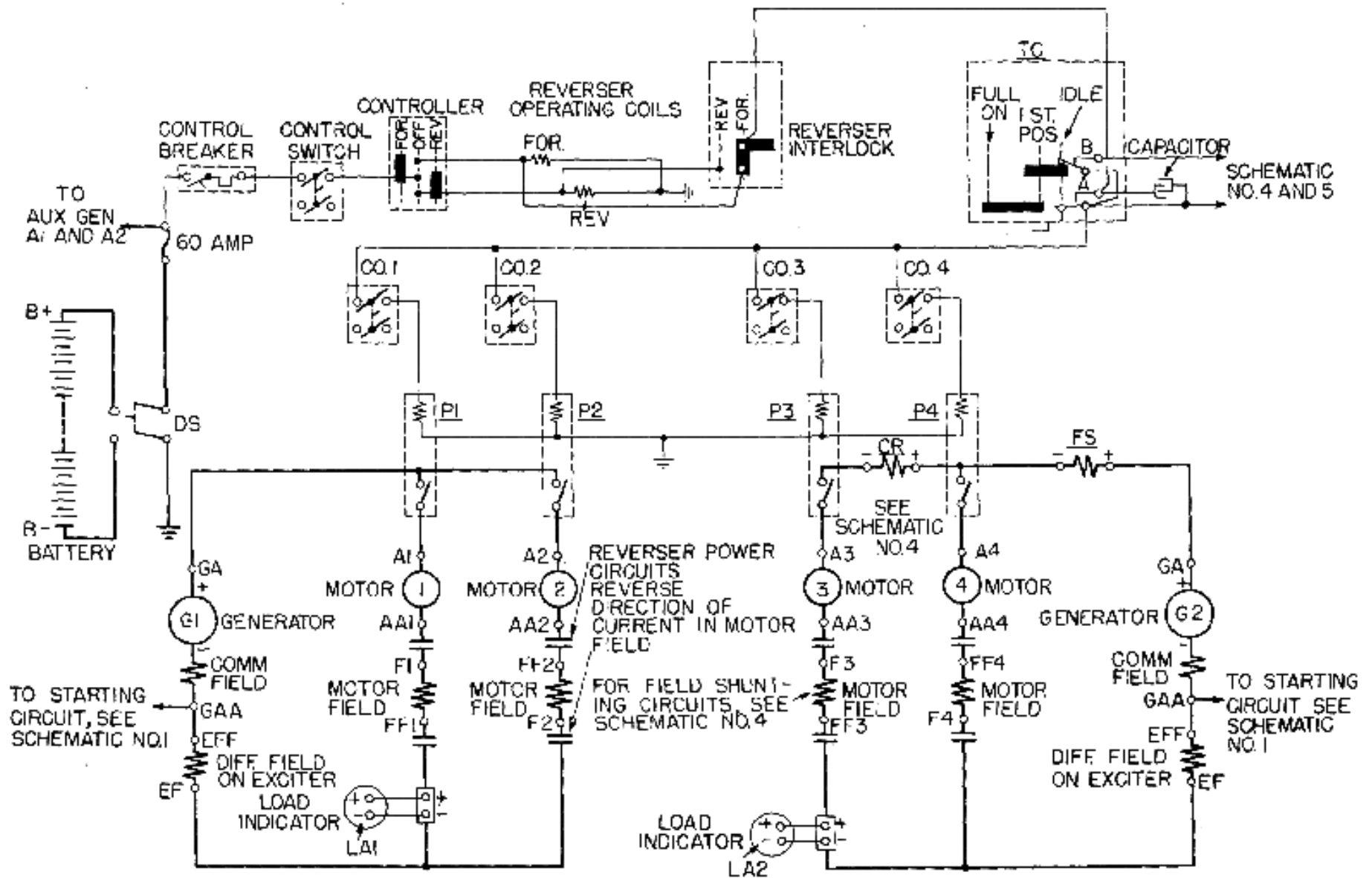


Fig. 27 Motor and control Schematic No. 3

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Motor and Control Circuits

Contactors P1, P2, P3, and P4 when closed, connect the traction generator G1 to motors No. 1 and No. 2, and tractor generator G2 to motors No. 3 and No. 4.

The contactors P1, P2, P3, and P4 close when the following sequence is completed.

1. Battery switch DS is closed manually.
2. Control breaker is closed manually.
3. Control switch is closed manually. Auxiliary generators are charging the battery. (In emergency, if the auxiliary generators are inoperative, the battery alone can supply voltage for the control circuits.)
4. Controller is in either the Forward or Reverse position. Reverser is in the position corresponding to the position of the controller.
5. Throttle is on the first position or beyond.
6. Contact A is closed on the throttle switch T C. 7. Motor cutout switches C01, C02, C03, and C04 are closed manually.
8. Then contactors will close, connecting motors to generator.

Possible Causes of Trouble

If contactors P1, P2, P3, and P4 do not close:

1. Check battery voltmeter to see that there is control voltage available.
2. Check control breaker to see if it is tripped.
3. Check for loose, open, short-circuited, or grounded wires and connections.
4. Check contacts of control and cutout switches.
5. Check contacts on controller, reverser, all interlocks, and TC switch.
6. See that the reverser has thrown to the correct position.

If contactors P1, P2, P3, and P4 close, but motors do not turn over, check for:

1. Proper contact of reverser main contacts.
2. Poor motor-circuit connections.
3. Internal trouble in traction generators and traction motors.

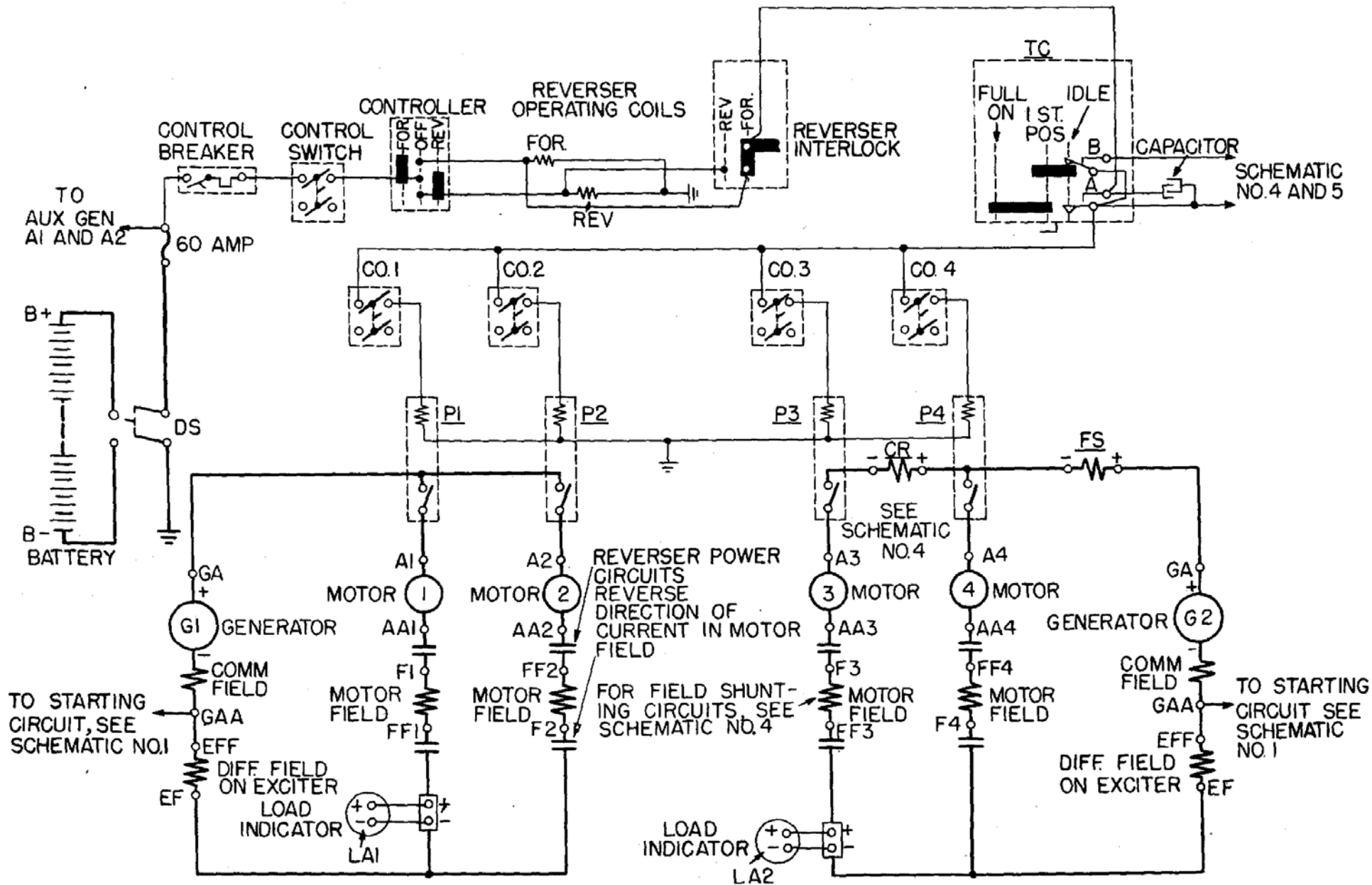


Fig. 28. Motor field-shunting circuits, Schematic No. 4

Motor Field-shunting Circuits

Full utilization of the available diesel-engine output and more power for traction at higher locomotive speeds is obtained by weakening the motor field. This is accomplished by paralleling the motor field with a resistor, and is called motor field shunting. The result is somewhat similar to overdrive in an automobile.

Field-shunting operation takes place as follows:

When throttle is advanced beyond the idling position:

1. Contact A on TC closes, thus closing contactors P1, P2, P3, and P4 as described under Motor and Control Circuits.
2. Contact B on TC, which is closed in the idling position, remains closed when contact A first closes.
3. The armatures of relays CR and FS close. This opens one contact on CR and closes the other. This also opens the contacts of FS.
4. Relay CR remains closed through its own closed contact.
5. The currents in the motor circuits aid in keeping the armatures of relays CR and FS closed through their series coils. (See Schematic No. 3.)

When throttle is further advanced:

1. Contact B on TC opens, thus de-energizing the shunt coils of FS relay.
2. The armature of relay FS remains closed through its series coil.

As the locomotive speed increases, and the tractionmotor current decreases:

1. Relay FS drops out, because of decrease of current in the series coils, thus closing its contact.

2. Field-shunting contactors close in the following sequence, M3, M4, M1, and M2, causing field shunting on motors No. 3, 4, 1, and 2, respectively.
3. The shunt coil of relay CR is de-energized, but the armature of CR is held closed by its own series coil.

When maximum permissible locomotive speed is reached:

1. Relay CR opens, because of the decrease in current through its series coil.
2. Contactors M1, M2, M3, and M4 open, removing motor field-shunting connections.
3. To re-establish field-shunting connections, the speed of the locomotive must be reduced and the throttle shut off far enough to close contact B on switch TC. Field shunting can then be re-established by the sequence described above.

If, with the field-shunting contactors closed, the locomotive load increases so that the tractionmotor current increases beyond a certain value:

1. The armature of relay FS closes by the current in the series coils, thus opening the relay contact.
2. Contactors M1, M2, M3, and M4 drop out, removing motor field-shunting connections.

Possible Causes of Trouble

If field shunting is not obtained as above, check for:

1. Loose, open, short-circuited, or grounded wires and connections.
2. Poor contacts on TC switch, cutout switches, relays, and interlocks.
3. With battery switch open, check contactors and relays by hand for free action.

Generator Field Circuits

Field GF1 (GF2) of traction generator G1 (G2) is excited by the armature of exciter E1 (E2). Field EF1 (EF2) of exciter E1 (E2) is excited from its own armature through a resistor, and from the armature of auxiliary generator A1 (A2) through contactor A1 (A21), contactor EF1 (EF21), and a resistor.

The excitation circuit for exciter field EFI (EF2) is complete when the following sequence has taken place.

1. Exciter-field cutout switches are closed manually.
2. Starting contactor GS1 (GS21) is open. (See Schematic No. 1.)
3. Auxiliary-generator contactor A1 (A21) is closed as described under Battery-charging Circuits. (See Schematic No. 2.)
4. Motor line contactors P1, P2, P3, and P4 are closed as described under Motor and Control Circuits.
5. Contactor EFI (EF21) is closed.

Possible Causes of Trouble

Any trouble in the generator field circuit will usually result in a loss of power delivered by the generator. This will be indicated by a low reading on one load indicator as compared with that on the other. If the difference in load readings is relatively small, it is probably due to a difference in engine or generator adjustment, and it will probably be difficult or impossible to determine the cause while the locomotive is in service.

If there is a considerable difference in load indicator readings, accompanied by a noticeable loss of locomotive power, make the following checks:

1. See if the engine speeds are approximately the same, as the throttle is opened step by step.
2. See that motor contactors P1, P2, P3, and P4 are closed.
3. See that the reverser fingers are making good contact.
4. See that contactor EFI (EF21) is closed. If not, check for loose connections or grounds in the contactor control circuit. (Schematic No. 5.)
5. Check exciter field circuit, including contactors A1 (A21), EFI (EF21), resistor EFRI (EFR21), etc., for loose connections, open circuits, or grounds.
6. Check for loose connections or grounds in the armatures and fields of the exciter E1 (E2) and generator G1 (G2).

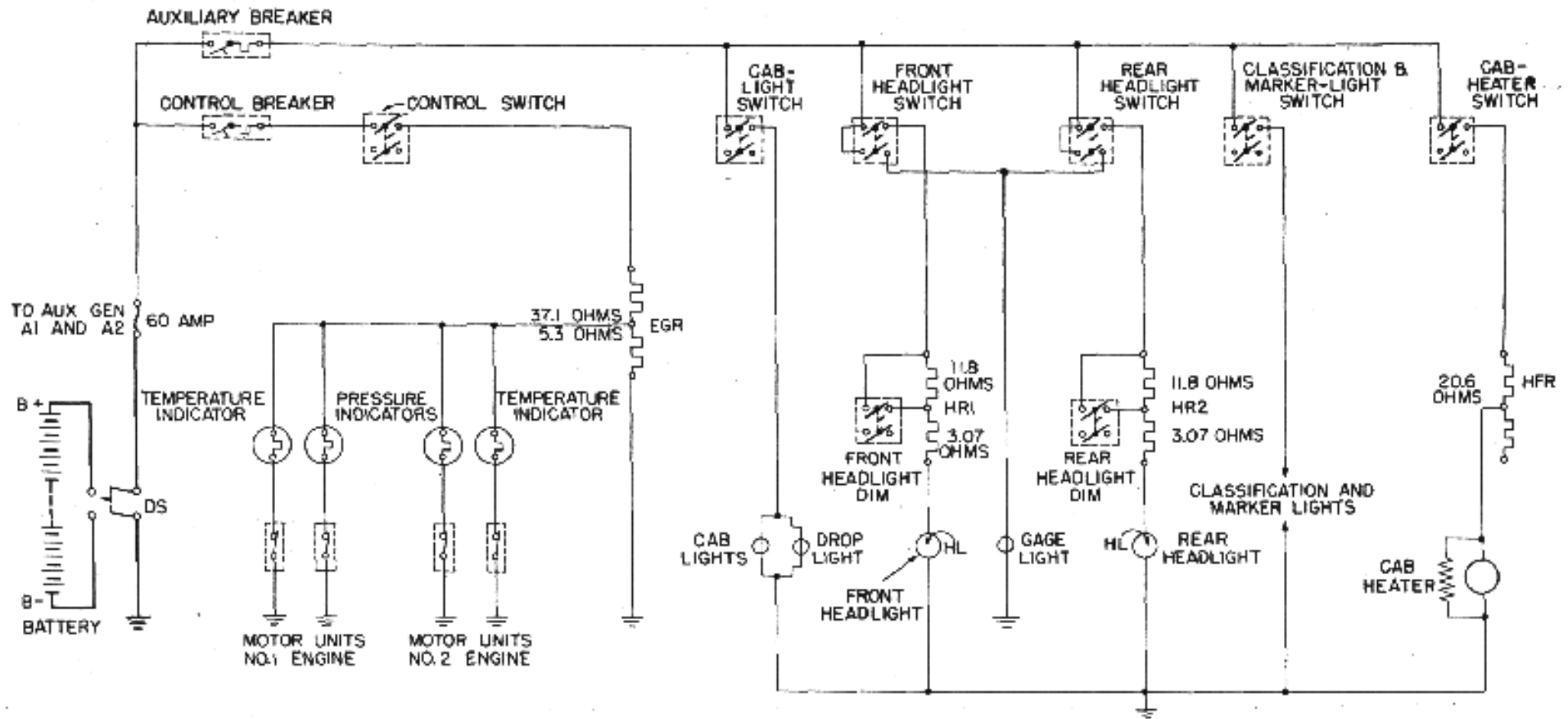


Fig. 30. Light and accessory circuits, Schematic No. 6

Light and Accessory Circuits

The various lighting and auxiliary circuits are connected across the control voltage supply as shown.

Control switches are provided in all the light and accessory circuits. These circuits are protected by circuit breakers.

Cab Light
Front Headlight
Rear Headlight

Classification and Marker Lights
Heater Fan Motor
Temperature and Pressure Indicators

Possible Causes of Trouble

If lights or auxiliary equipment fail, inspect for:

1. Tripped circuit breaker.
2. Loose, open-circuited, or grounded connections.
3. Poor contact of the circuit switch.
4. Defective individual lamp or motor.

CONDITION	THROTTLE SWITCH		CONTACTORS														RELAY *
	TC		P1	P2	P3	P4	M1	M2	M3	M4	GS1	GS21	EF1	EF21	A1	A21	FS
	A	B															
NO.1 ENGINE START		●									●						
NO.2 ENGINE START		●										●					
IDLING		●															
FULL FIELD RUNNING	LOW SPEED	●	●	●	●	●							●	●	●	●	●
	HIGH SPEED	●	●	●	●	●							●	●	●	●	●
REDUCED FIELD		●	●	●	●	●	●	●	●				●	●	●	●	●
MAX SPEED CONNECTION WITH NO.1 ENGINE SHUT DOWN & WITH CO1, CO2, & NO.1 EXCITER FIELD SWITCHES OPEN		●			●	●								●		●	
MAX SPEED CONNECTION WITH NO.2 ENGINE SHUT DOWN & WITH CO3, CO4, & NO.2 EXCITER FIELD SWITCHES OPEN		●		●	●								●		●		
MAX. SPEED CONNECTION WITH A MOTOR CUT OUT	NO. 1 CO	●		●	●	●							●	●	●	●	
	NO. 2 CO	●		●	●	●							●	●	●	●	
	NO. 3 CO	●		●	●	●							●	●	●	●	
	NO. 4 CO	●		●	●	●							●	●	●	●	

*THIS TABLE INDICATES THE POSITION OF THE ARMATURE OF FIELD-SHUNTING RELAY FS. THE RELAY CONTACTS ARE NORMALLY CLOSED WITH THE OPERATING COIL DE-ENERGIZED AND THE ARMATURE OPEN.

Fig. 31. Contactor-sequence table

The 0 indicates that the device is closed. This chart should be used in conjunction with the preceding schematic diagrams showing which devices are closed under the various operating conditions.

Contactors P1, P2, P3, P4, EF1, and EF21 will close and open by operating the throttle with the diesel engine shut down and the battery switch closed.

Contactors GS1, GS21 are checked by operation of engine push buttons, Before doing this, insert a thin piece of insulating material between the contacts on both contactors.

The sequence of the remaining contactors and relays is dependent upon current flow in their series coils and generated voltages. Hence, it is necessary to operate the locomotive to test them.

Section 5

Air-broke System

(See Fig. 32)

Description

The No. 14 EL brake equipment provides braking which may be applied or released independently of, or in conjunction with, the train brakes.

It consists of the following parts:

1. Two belt-driven air compressors-supply the air.
2. One air-compressor governor, or unloader-automatically controls the operation of the compressor between minimum and maximum pressures.
3. A safety valve-protects against excessive main-reservoir pressure, in case the governor or unloader fails to control the air-compressor pressure.
4. Two main reservoirs-receive the compressed air from the compressors, where the air is cooled to atmospheric temperature and stored for use in charging the brake system.
5. An equalizing reservoir--adds volume to the space above the equalizing piston in the brake valve, so that reductions in brakepipe pressure may be properly made during service applications of brakes.
6. A feed valve-automatically maintains a predetermined normal pressure in the brake system.
7. A reducing valve-reduces main-reservoir air pressure for independent-brake operation.
8. A duplex air gage-indicates equalizing-reservoir and mainreservoir pressures.
9. A duplex air gage-indicates the brake-pipe and brakecylinder pressures.
10. Two brake valves consist of an automatic and an independent control. The automatic portion controls the operation of the locomotive and train brakes. This handle is the lower one on the brake valve. By proper movements of the automatic-brakevalve handle, the engineman is able to:

- a. Charge the entire air system on the locomotive and train.
- b. Apply the brakes and hold them applied.
- c. Release the brakes on the locomotive and train.
- d. Hold the locomotive brakes applied while releasing the train brakes and recharging the entire system.

By proper movements of the independent-brake-valve handle, which is the upper one, the engineman is able to a. Operate the locomotive brakes independently of the train brakes at any time.

11. A distributing valve-automatically:
 - a. Controls the flow of air from the main reservoirs to the locomotive brake cylinders when the brakes are applied.
 - b. Controls the flow of air from the brake cylinders to the atmosphere when the brakes are released.
 - c. Maintains locomotive brake-cylinder pressure against leakage, keeping the pressure constant when holding with brakes applied.
12. Two brake cylinders on each truck, with pistons and rods so connected by brake levers to the brake shoes that, when the pistons are forced outward by air pressure, this force is transmitted through the rods and levers to the brake shoes and applies them to the wheels.
13. Centrifugal dirt collectors-for protection of the distributing, . feed, and reducing valves. The function of the dirt collector is to prevent pipe scale, cinders, or foreign material of any kind from reaching these valves.
14. A combined strainer and check valve-together with a cutout cock, enables the brakes on a locomotive being towed dead in a train to be operated like those of any car on the train. This is called the dead-engine fixture.
15. Main-reservoir pipe-has branches leading to:
 - a. Distributing valve.
 - b. Feed valve.
 - c. Reducing valve.
 - d. One duplex air gage.
 - e. Brake valve.
 - f.
16. Brake pipe-has branches leading to:
 - a. Brake valve, and then throughout the length of the locomotive and train.
 - b. Distributing valve.
 - c. Operating valve on each car of the train.
 - d. One duplex air gage.

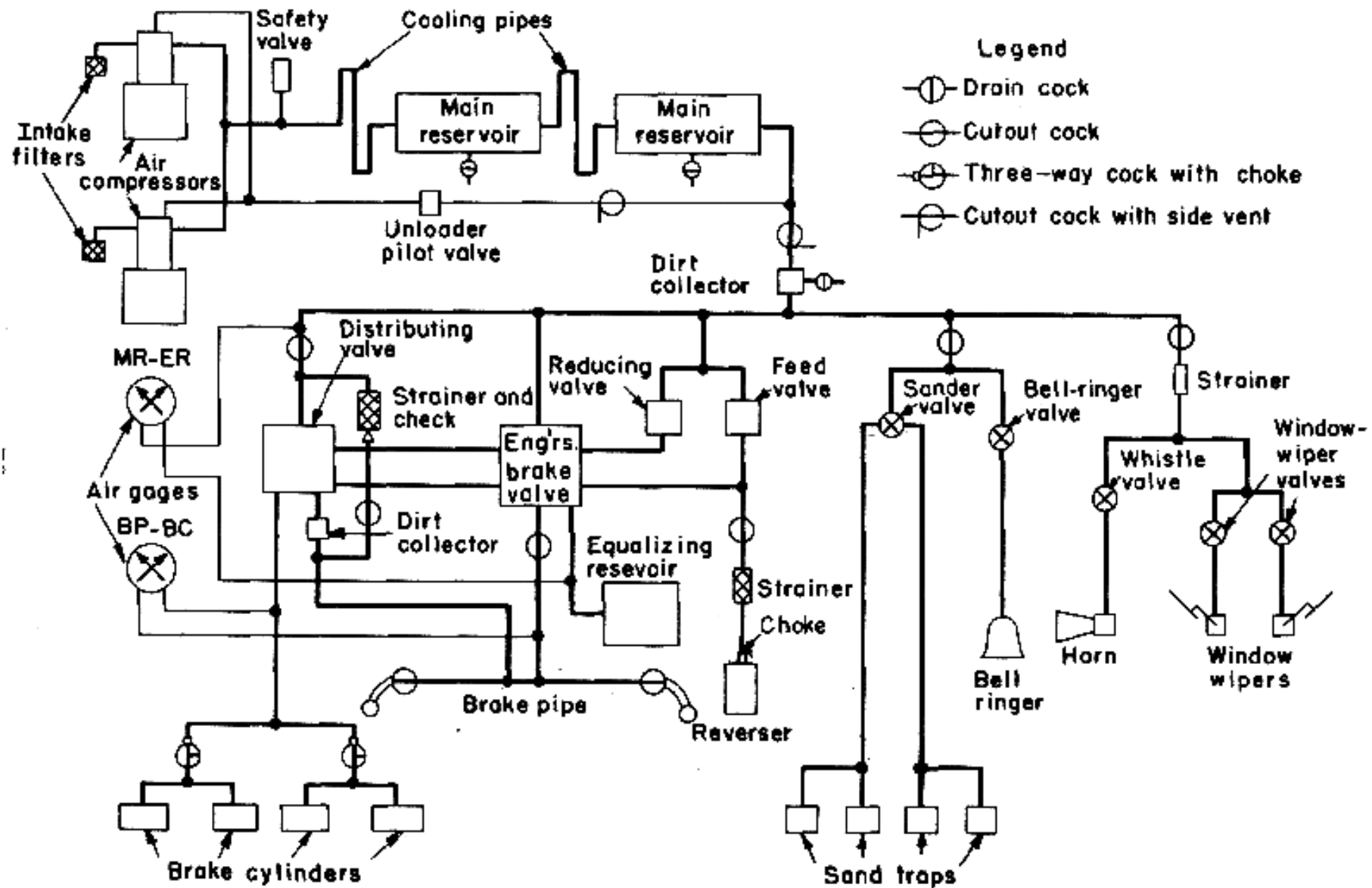


Fig. 32 Schematic daigram of air piping

AIR-BRAKE SYSTEM

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17. Various cutout cocks hose, couplings, etc.-the location and uses of which can be readily seen by referring to piping diagram, Fig. 32.

Automatic-brake-valve Positions

(Refer to Fig. 33) (Lower Handle)

1. *Release Position.* It provides a large and direct passage from the main reservoir to the brake pipe, to permit a rapid flow of air into the brake pipe. This accomplishes the following

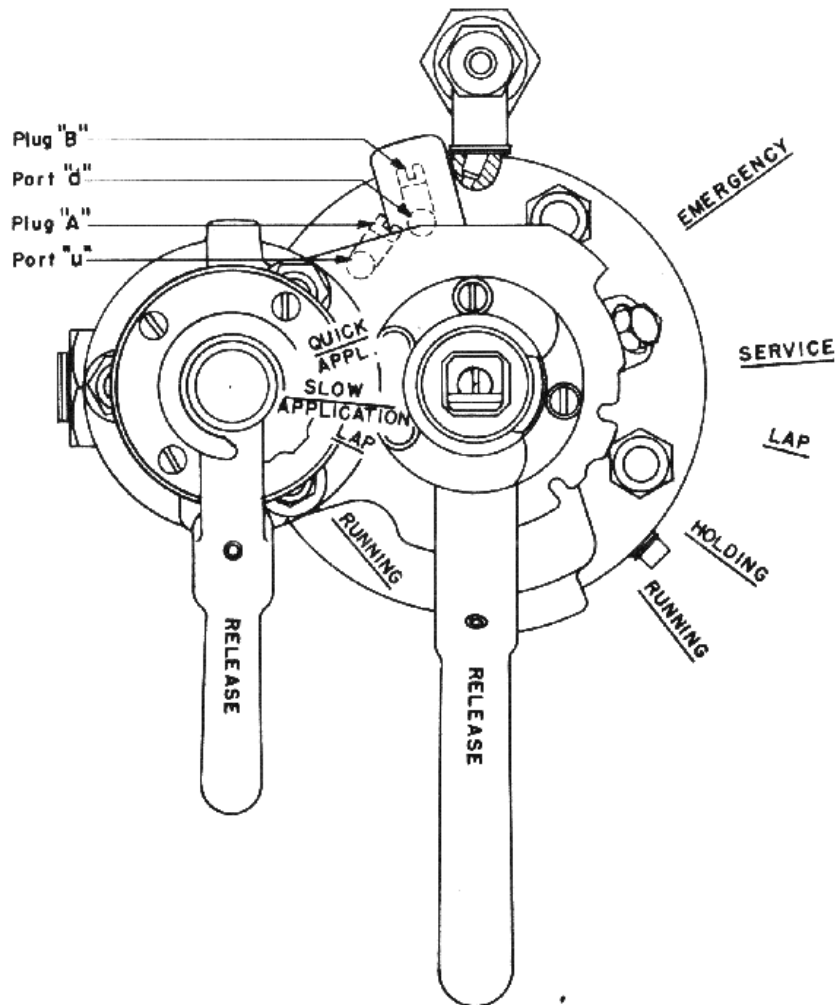


Fig. 33. Engineman's brake valve

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- a. Charges the train-brake system,
- b. Causes a quick release of the train brakes, but does not release locomotive brakes, if they are applied.

If the handle were allowed to remain in this position, the brake system would be charged to main-reservoir pressure. To avoid this, the handle must be moved to Running or Holding position. A small port discharges feed-valve-pipe air to the atmosphere in release position with sufficient noise to attract attention to the handle position.

2. *Running Position.* The handle is in this position:
 - a. When the brake pipes are charged and ready for use;
 - b. When the brakes are not being operated (released) ;
 - c. To release the locomotive brakes.

In this position, a large direct passage is opened from the feedvalve pipe to the brake pipe, so that the latter will charge up as rapidly as the feed valve can supply the air, but cannot attain a pressure above that for which the feed valve is adjusted. The equalizing reservoir charges uniformly with the brake pipe, keeping the pressure on the two sides of the equalizing piston equal. The distributing-valve release pipe is connected with the atmosphere.

3. *Service Position.* This position gives a gradual reduction of brake-pipe pressure to cause a service application. The gradual reduction is to prevent quick action. The brake-pipe discharge is also gradually stopped to prevent the pressure at the head end of the brake pipe being built up by the air flowing from the rear which might cause some of the head brakes to "kick off."

4. *Lap Position.* This position is used while holding the brakes applied after a service application, until it is desired either to make a further brake-pipe reduction or to release them. All ports are closed. The removal of a plug in the rotary-valve seat permits release of the locomotive brakes, in case_ it is desired to hold train brakes only in this position. This plug is designated as Plug'B, Fig. 33, in port d which connects the distributing-valve release pipe to atmosphere. With the equalizing slide valve of the distributing valve in Lap, the brake on the locomotive is held applied with the train. When the brake-valve handle is moved to Release or Running and returned to Lap with graduated-release equipment, the train brakes remain applied, but the

AIR-BRAKE SYSTEM

locomotive brakes are released if Plug B is removed.

5. *Release Position.* This position, which is used for releasing the train brakes after an application, without releasing the locomotive brakes, has already been described under,Charging and Release.

Main-reservoir air is admitted to the brake pipe, raising the pressure in the latter, thereby causing the car operating valves and equalizing portion of the distributing valve to go to release position, which releases the train brakes and recharges the auxiliary reservoirs and the pressure chamber in the distributing valve. When the brake-pipe pressure has been increased sufficiently to cause this, the handle of the brake valve should be moved to either the Running or the Holding position; the former when it is desired to release the locomotive brakes, and the latter when they are to be still held applied.

6. *Holding Position.* This position is so named because the locomotive brakes are held applied while the train brakes are being released and their auxiliary reservoirs recharged to feedvalve pressure. In case the use of this position is not desired, the removal of a plug in the rotary-valve seat causes the brake valve to function the same in Holding as in Running position. This plug is designated as Plug A, and is located in the passage between port u and distributing-valve release pipe; see Fig. 33.

7. *Emergency Position.* This position is used when the quickest and heaviest application of the brakes is required. A large and direct communication is made between the brake pipe and atmosphere. This direct passage permits a sudden and heavy discharge of brake-pipe air, causing the triple valves and distributing valve to move to Emergency position which gives maximum braking force in the shortest possible time. In this position also, locomotive brake-cylinder pressure is maintained against leakage.

Independent-brake-valve Positions

(Refer to Fig. 33) (Upper Handle)

1. *Release Position.* This position is used to release the locomotive brakes when the automatic-brake-valve handle is not in Running position. It also may be used to release locomotive brakes after an independent application at a faster rate than obtainable in Running position. The independent portion of the

brake valve is provided with a return spring which automatically moves the handle from *Release* to *Running* position as soon as the engineman releases his hold on it, the purpose being to prevent the handle from being left in Release position, and thereby making it impossible to operate the locomotive brakes with the automatic-brake-valve handle. As a warning to the engineman in case of a broken return spring, air from the reducing valve is allowed to escape to the atmosphere with the Release position.

2. *Running Position.* In this position, communication is established through the distributing-valve-release pipe, between the application cylinder of the distributing valve and a port in the automatic portion of the brake valve, so that the distributing valve can be released by the latter. If the handle of the automatic portion is in Running position and the locomotive brakes are being operated, they can be released by simply returning the independent-brake-valve handle to Running position.

3. *Lap Position.* This position is used to hold the independent brake applied after the desired cylinder pressure is obtained, at which time all communication between operating ports is closed.

4. *Slow-application Position.* Locomotive brakes are applied slowly in this position.

5. *Quick-application Position.* This position gives a quick application of locomotive brakes. The same spring that automatically returns the handle from Release to Running position also returns it from Quick-application to Slow-application position when the engineman releases his hold on it. The action of the spring between these two latter positions serves to make the Quick-application position more prominent, so that, in rapid movement of the handle, the engineman is less likely to pass over unintentionally to Quick-application position, thereby obtaining a heavy application of the locomotive brakes when only a light one is desired.

Troubles and Remedies

Broken Pipes

Main-reservoir Pipes: If the main-reservoir pipe breaks between the reservoir and the branch to the distributing valve in such a way that it cannot be repaired, the locomotive brake cannot be applied by either brake valve. If the break is between the brake valve and the branch pipe leading to the distributing valve, both sides of the main-reservoir pipe should be plugged, and

the locomotive brakes can be operated in the usual manner with the independent-brake valve.

Main-reservoir Branch Pipes: If the branch pipe from the main-reservoir pipe to the distributing valve breaks between the main-reservoir pipe and the cutout cock, plug the main-reservoir side of the break and close the branch-pipe cutout cock. The locomotive brakes are then inoperative. The train brakes can be operated in the usual manner.

If the branch pipe leading to the feed valve and reducing valve breaks, both sides must be plugged. This cuts out the independent-brake valve, and the use of Running (for releasing and recharging the train brakes) and Holding positions of the automatic-brake valve. As there would be no pressure on top of the independent rotary valve to hold the valve to its seat, it would be impossible to attain automatic application of the locomotive brakes. To remedy this, move the independent-brake-valve handle to Slow-application position before applying the brakes, and leave it there until it is desired to again release the locomotive brakes. When the automatic brakes are released, return the independent-brake-valve handle to Running position. The train brakes are released and recharged with the automatic-brake-valve handle in Release position. The locomotive brakes can be released by moving the handle of the automatic-brake valve to Running position, or by Release position of the independent-brake valve.

If the break occurs between the reducing valve and the branch pipe leading to the feed valve, plug both sides of the pipe. This cuts out the independent-brake valve, but does not interfere with the handling of the locomotive and train brakes with the automatic-brake valve, except that the independent-brake valve must be manipulated as described in the preceding paragraph.

When the pipe is broken beyond the feed valve or reducing valve, it is not necessary to plug the pipe leading from these valves, since the same result can be accomplished by turning the adjusting nut sufficiently to loosen the regulating spring and cause the blow of main-reservoir air to cease.

Another remedy in case the pipe is broken beyond the reducing valve is to slack off the reducing-valve adjusting nut, as just described, plug the broken pipe toward the independent-brake valve, and plug the exhaust port in the bottom of this brake valve. The independent-brake-valve handle should then be kept in Running position. The locomotive brakes can then be operated by the automatic brake valve.

Brake Pipe: In case of a broken brake-pipe branch to the distributing valve,

plug the end leading from the brake pipe. The train brakes may then be operated in the usual manner, but the locomotive brakes cannot be operated by the automatic brake valve. The locomotive brake can be operated by the independent brake valve in the ordinary way, except that Release position must always be used to release it.

If the break is ahead of the branch pipe to the distributing valve, the distributing-valve side of the break may be plugged without affecting brake operation.

If the break occurs between the branch pipe to the distributing valve and the branch to the automatic-brake valve, plug the pipe as above. It will be impossible to apply and release the brakes by the automatic-brake valve, but they may be applied and released by the independent-brake valve.

Brake-cylinder Pipe: A broken brake-cylinder pipe permits escape of main-reservoir air when the brake is applied, and may cause the release of one or more of the locomotive brake cylinders, depending upon where the break occurs. If the break occurs next to the distributing-valve reservoir, close the cutout cock in the main-reservoir supply pipe to the distributing valve.

Application-cylinder Pipe: If the application-cylinder pipe breaks, plug the pipe on the distributing-valve side of the break. If the break occurs between the distributing valve and the tee to the independent- and automatic-brake valves, the locomotive brakes cannot be applied with the independent-brake valve, and the emergency maintaining feature is lost; the locomotive brakes can, however, be applied as usual by the automatic-brake valve, and released by that valve in Running position. If the break is between the automatic valve and the tee, the independent brake can be applied and released in the usual way, but the emergency maintaining feature is lost. If the break occurs between the tee and the independent-brake valve, the locomotive brakes cannot be applied by the independent-brake valve, but the emergency maintaining feature is retained.

Distributing-valve Release Pipe: If the release pipe breaks, the holding feature is lost, and it is also impossible to keep the locomotive brakes fully applied with the independent-brake valve, unless the opening from the distributing-valve side of the break is closed. This should not be done, except possibly in switching service, where the independent-brake valve is mostly used, and it is then necessary to use the Release position of the independent-brake valve at all times when it is desired to release the locomotive brakes. On road locomotives, the distributing valve side of the break should be left open, and the brakes

controlled by the automatic brake valve until repairs can be made.

Equalizing-reservoir Pipe: In case of breakage of the equalizing reservoir pipe, plug this pipe at the brake-valve union, and also plug the brake-pipe service exhaust. Then, to apply the brakes, move the handle of the automatic-brake valve gradually toward *Emergency* position, making the desired brake-pipe service reduction gradual and direct, then return the handle gradually to Lap position.

Brake-shoe Adjustment

As brake shoes wear, the brake-cylinder piston travel, when brakes are applied, will increase. Piston travel should not be permitted to exceed 5 1/4 in. To adjust brake rigging to compensate for shoe wear, proceed as follows. Refer to Fig. 34.

1. Loosen lock nuts.
2. Turn compression rod in clevises until shoes clear tread of wheel by 1/4 in. Compression rod has right- and left-hand threads; hence it operates like a turnbuckle.
3. Tighten lock nuts.
4. Apply brakes. Cylinder travel should be 2 1/2 in.
5. Release brakes. See that shoes clear wheel tread.

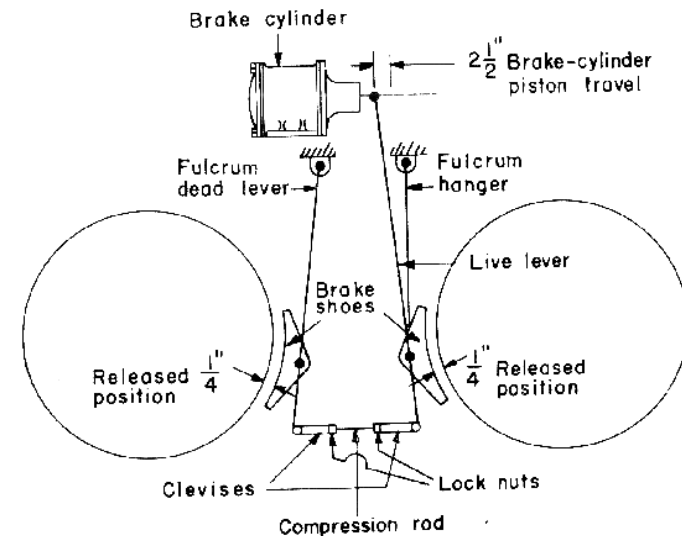


Fig. 34. Schematic diagram of brake rigging

Section 6

Accessories

Cab Heater

The cab heater (Fig. 5A) is of the hot-water-radiator type, connected to the diesel-engine water system. The heat is blown into the cab by means of an electric fan which is connected to the control circuit by means of a manually operated switch and circuit breaker.

Sanding Equipment

The sanding equipment consists of

1. Sand boxes which serve as storage receptacles for the sand supply.
2. Sand traps to which the sand flows by gravity from the sand boxes.
3. Air piping and an air valve in the engineman's control station, for controlling the compressed air which carries the sand from the trap to the rails.

Horn

The horn (Fig. 1) is of the vibrating-diaphragm type, controlled by an air valve in the engineman's control station.

Bell

The bell is stationary, with a movable clapper actuated by an air-operated ringer which is controlled by a valve in the engineman's control station,

Windshield Wipers

These are installed on the windows in front and in back of the engineman, and are controlled by a valve located in the engineman's compartment. The windshield wipers are operated by compressed air, and should be checked frequently for air leaks in the wiper itself or in the connections.

Section 7

Fuel and Lubrication Recommendations

(For more detailed information on lubrication, see the Maintenance Instructions)

Diesel-engine Fuel

While the diesel engine will operate on almost any petroleum fuel for some time, continued satisfactory and economical operation will result only when good grades of clean distillates are used.

1. Buy clean fuel.

In the United States of America and Canada, usually commercial No. 3 domestic-burner fuel provides satisfactory, as well as the most economical, operation. "Diesel Fuels" at premium prices are seldom required for locomotive-type engines. However, in some export territories, the wide variation in quality of fuels available will not permit making simple recommendations, as is the case in the United States of America and Canada. For this reason, we suggest the diesel-engine manufacturer be consulted for recommendations concerning satisfactory diesel fuels.

In sub-zero (-18 C) weather, where warm storage is not provided for the machine, distillates with unusually low pour points may be required. The fuel must be sufficiently fluid to be drawn from the main tank to the engine transfer pump at the lowest temperature at which the engine must start and operate. The diesel-engine manufacturer is familiar with this requirement, and should be consulted regarding the proper fuel to use when cold temperatures are encountered.

The most important qualification of diesel fuel is cleanliness. To keep the fuel-injection equipment in its most efficient condition, it is necessary to keep all dirt, dust, water, and sediment out of the fuel.

Too much emphasis cannot be placed on the importance of using only clean diesel fuel. In selecting a fuel, it should be pointed out that distillates are especially desirable because, in refining, they are heated to a vaporous state and condensed in another container, leaving all sediment and residue behind in the still.

2. Keep the fuel clean.

It is important to buy clean fuel, and to keep it clean. The best fuel can be rendered unsatisfactory by inadequate storage facilities or

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careless handling. The clearance between the fuelinjection-pump plunger and the barrel is very small, actually less than 0.0001 in. (0.00254 mm), which makes it evident that the invisible particles of dirt which might pass through the filters can damage these finely finished parts.

Effort should be constantly exerted to prevent contamination of the fuel. An important step is to reduce the number of times the fuel must be handled. When the fuel can be delivered by the distributor to storage tanks, and then pumped from the storage tank to the engine tank, handling is minimized.

Since natural settling is an effective method of cleaning diesel fuel, the fuel should be allowed to stand at least 24 hours in the storage tank after it has been filled, before fuel is transferred to the engine tank. Be sure to drain all water and sediment that has settled to the bottom of the tank before the tank is refilled. Occasionally, drain all of the fuel and clean the tank thoroughly.

The use of cans, funnels, and drums should be discouraged, since it is practically impossible to keep such equipment absolutely clean. If drums must be used, they should be allowed to stand for at least 24 hours before drawing off fuel. The drum should stand on end, and the inlet for the pump be kept several inches above the bottom, to prevent stirring up the sediment that settles to the bottom.

Whatever method is used, see that only clean fuel enters the engine tank.

Fill the engine tank at the end of the day, because the incoming fuel will drive out the moisture-laden air and prevent condensation. Every 120 hours before starting the engine, open the drain for the fuel tank and drain any sediment or water which may have accumulated.

Diesel-engine Crankcase Lubricating Oil

Lubricating oils, known as Superior All-purpose Lubricants for Caterpillar Engines, have been developed during the past few years. These oils have such characteristics that they provide superior lubrication for Caterpillar diesel engines. Your nearest Caterpillar distributor can give you brand names of these oils that are available in your territory. We recommend the use of these oils in the crankcase lubricating system of Caterpillar engines.

FUEL AND LUBRICATION RECOMMENDATIONS

These oils are available in various viscosity grades. It is important to use the correct viscosity grade, taking into account the current outdoor temperature and the probable temperature range which is likely to be encountered before the next oil change.

Recommended Oil-viscosity Grades

Use SAE No. 20*	At temperatures above freezing.
Use SAE No. 10	In weather below freezing. This grade is particularly needed for easy cranking and good oil circulation in cold weather.

*SAE No. 30 may be used satisfactorily in very hot weather.

Lubrication Diagram

Detailed instructions regarding lubrication are given in the following lubrication schedule. Careful attention to these instructions and proper selection of lubricants will add much to locomotive performance, reliability, and economy.

It is important to use the correct lubricant in the correct amount. for each point. Too much is as bad as too little. Oil or grease on insulating material gathers dust and dirt, causing the insulation to break down electrically. When lubricating apparatus, keep lubricant from insulated parts. Remove immediately with a clean, lintless rag any lubricant that accidentally gets on such parts.

When preparing to refill with fresh oil, every compartment should be drained while warm, preferably after the engine has run for some time. Most of the sediment will then be in suspension and, therefore, will drain readily.

Recommended Lubrication Schedule (See Fig. 35)

Daily Lubrication Schedule

The following numbers refer to lubrication points on Fig. 35. 1. Check oil level of diesel-engine crankcase with bayonet gage, and add oil, if necessary, to bring level to Full mark on gage with engine running and oil warm. See Fig. 36A to 36E.

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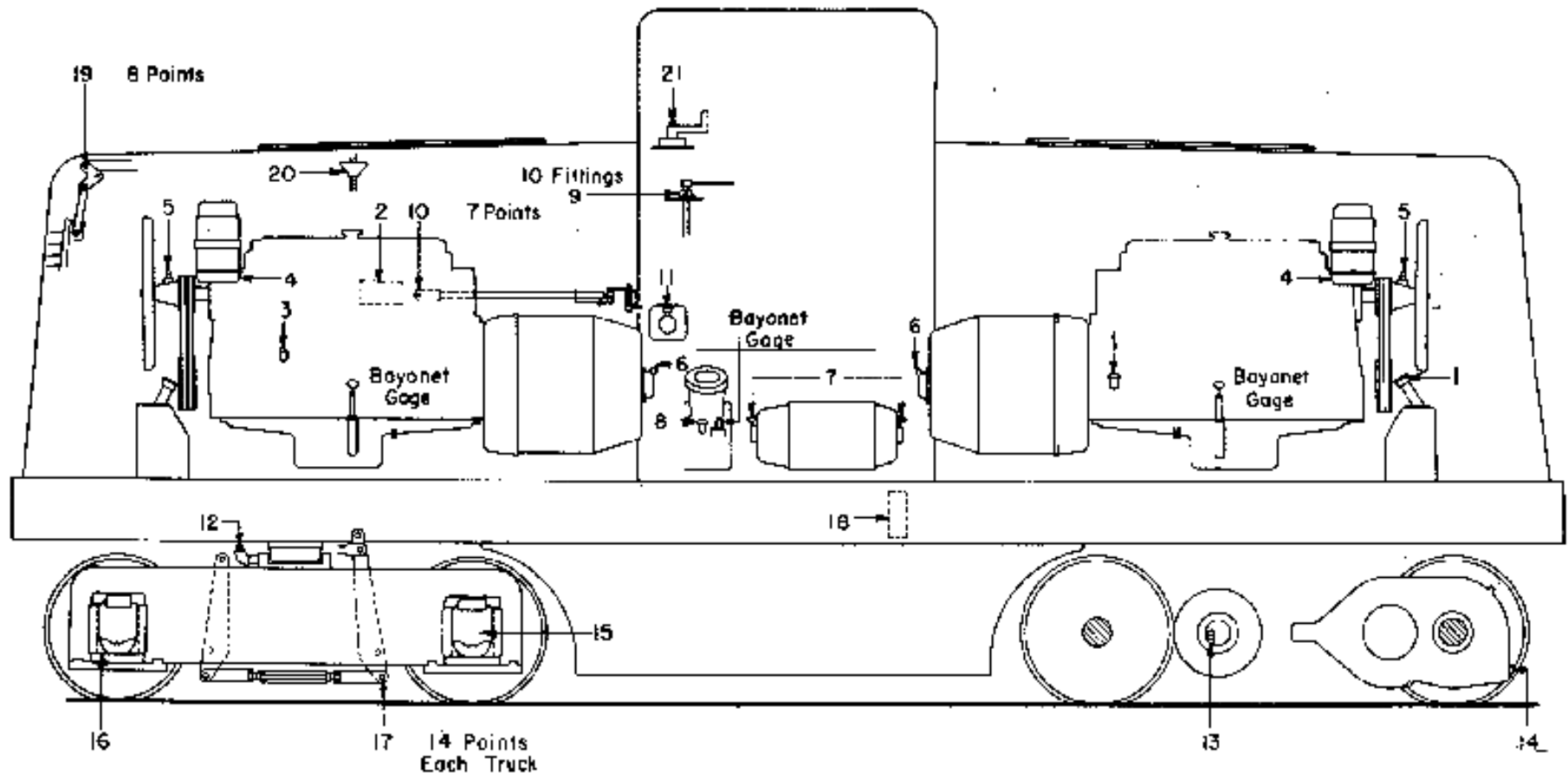


Fig. 35 - Lubrication diagram

FUEL AND LUBRICATION RECOMMENDATIONS

Recommended lubricant-Superior All-purpose Oil.

After the first 30 hours' operation of a new diesel engine, drain and refill the crankcase with one of the Superior All-purpose Lubricants for Caterpillar Diesel Engines. It is not essential to change the absorbent oil-filter elements at this time, unless the engine is operating in very dusty conditions.

4. Wash and refill oil pan on bottom of diesel-engine air cleaners. Recommended lubricant-straight mineral oil.
8. Check oil level of air compressor with bayonet gage, add oil, if necessary, at filler pipe to maintain level between high and low marks on gage. Recommended lubricant-good grade of air-compressor oil.
15. Fill journal-box bearings to level of cover, but not to overflow. Recommended lubricant-good grade of car-journal oil.
16. Grease journal-box pedestals, or use a heavy car-journal oil.
17. Oil the brake-rigging pins with heavy machine oil. Weekly

Lubrication Schedule

In addition to the items covered by the daily lubrication schedule, recommended procedure is as follows:
Point.

2. Check oil level of fuel-injection-pump housing with bayonet gage. Add oil, if necessary, to bring level to full mark on gage. See Fig. 37. Recommended lubricant-straight mineral oil.
3. Check oil level in hour-meter gear housing by removing plug on housing.

Recommended lubricant-*straight mineral oil*.

4. Wash screens of diesel-engine air cleaners. See Fig. 39.
14. Check oil level of traction-motor gear case. Maintain the oil level 1/4 in. from the bottom of the top filling plug.

Monthly Lubrication Schedule

In addition to the items covered by the daily and weekly lubrication schedules, recommended procedure is as follows:

1. Wash and refill the diesel-engine crankcase breather, wash the metallic filter elements, and repack the absorbent filter. See Fig. 36A to 36E.

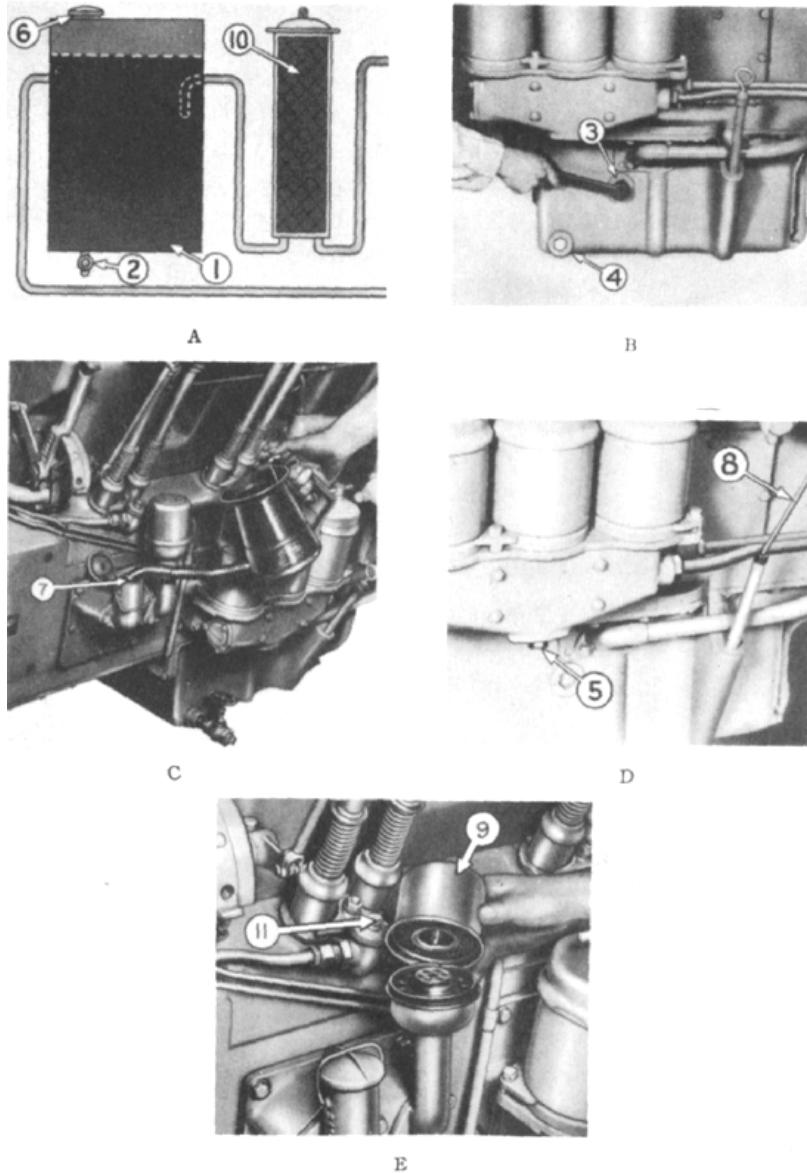


Fig. 36. Lubricating-oil system

Refer to Fig. 36 (Daily Lubrication)

Drain reservoir (1) by opening drain valve (2); also upper sump (3), lower sump (4), metallic oil filters (5), and absorbent oil filter (10). Close drains, and pour fresh lubricating oil into supply tank through filler cap (6) until it is up to the level of the overflow pipe to crankcase. Add additional oil through engine filler opening (7) to bring up to full mark on bayonet gage. Check oil level (8) daily, with engine running and oil warm. Wash engine breather (9) and pour t4 pint (11.125 liter) of oil through element, and replace. Wash metallic filter elements (5), dry thoroughly, and replace. Remove waste from absorbent oil filter (10), and repack with 7 lb lint-free waste. For crankcase-lubricating-oil and filter-element change periods, refer to chart.

2. Drain the oil in the fuel-injection-pump housing (Fig. 37) by opening drain valve 11, Fig. 36E. Close valve and refill to full mark on bayonet gage.

Recommended lubricant--straight mineral oil.

3. Drain, wash, and refill the hour-meter gear housing. See Fig. 38.

Recommended lubricant--straight mineral oil.

5. Grease the diesel-engine fan bearing. See Fig. 40. Recommended lubricant--G-E Ball-bearing Grease. 8. Change the oil in the air compressor. See Fig. 24A. Recommended lubricant- -good grade of compressor oil. 9.

Grease the throttle mechanism.

Recommended lubricantG-E Ball-bearing Grease.

10. Oil the pins and sliding parts of the throttle mechanism.

Recommended lubricantlight machine oil.

11. Oil the cab-heater motor bearings with one or two drops.

Recommended lubricant--- light machine oil.

12. Oil the center plates. Recommended lubricant-- heavv oil. Point.

18. Clean and lubricate the rc

Recommended lubricant-St Quaker Chemical Products Corp;

Questions and Answers

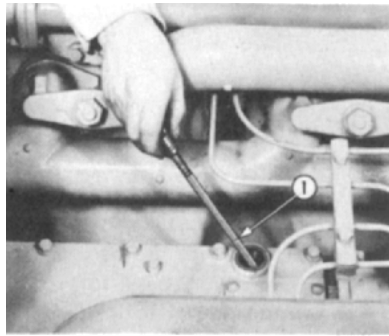


Fig. 37. Fuel-injection-pump housing

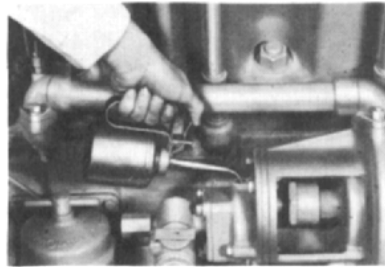


Fig. 38. Hour-meter gear housing

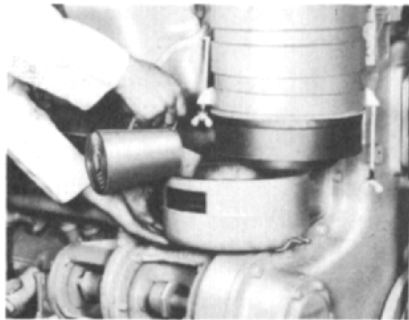


Fig. 39. Air cleaners

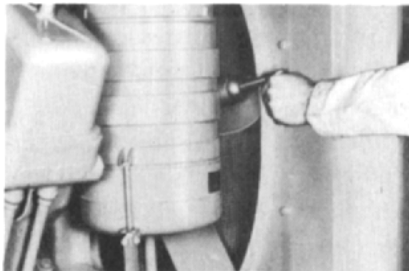


Fig. 40. Fan

- 19). Oil pins of winter-front control mechanism. Recommended lubricant-light machine oil.
- 20 21. Grease the Batch-operating mechanism. Recommended lubricantG-E Ball-bearing Grease. For six-months' and yearly Lubrication Schedules, see Maintenance Instruction Book.

Cooling System

- Q. How is engine cooling system filled?
- A. The engine cooling system is filled through filler pipes beneath the underframe. Each engine has a separate cooling system, and each system has two filler pipes, one on each side of the locomotive.
- Q. How much water should be carried in the engine cooling system ?
- A. Fill until water overflows through filler pipe on opposite side of locomotive. Each engine cooling system holds about 10 gallons.
- Q. How can it be determined if water is not circulating properly?
- A. Abnormally high temperatures will be indicated by engine cooling-water thermometers. Excessive localized heating indicates poor water circulation. Hold hand on cylinder heads, water pump, radiator, etc., and compare various degrees of heat to locate source of trouble. Avoid touching exhaust manifold or piping.
- Q. What is proper range of operating temperature for the cooling water?
- A. Between 110 F and 180 F.
- Q. What precautions must be made when the temperature is, or will be, below freezing?
- A. Drain the cooling system, or use a suitable antifreeze solution. The latter is preferable.
- Q. What precautions should be taken during layover periods in freezing weather?
- A. Light the water heaters. One is provided for each engine. See that there is sufficient kerosene in tank to last over the layover period Full tank will last approximately 36 hr. Close radiator shutters and hatch cover. Use a suitable antifreeze solution in the cooling system.
- Q. How are cab heaters cut into engine cooling system?
- A. By opening valves adjacent to each cab heater.
- Q. How is cooling-water temperature controlled?

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- A. Engines are provided with thermostatic by-pass valves which permit the cooling water to flow directly from the engine outlet to the pump inlet, instead of through the radiators, in order to maintain the engine temperature above the minimum operating value. The roof hatches, controlled by cranks in the cab, and radiator shutters, controlled by levers in the cab, should be opened sufficiently to prevent diesel-engine water temperature rising higher than 180 F.
- Q. If engines should overheat because of insufficient water in the cooling system, what should be done?
- A. Engines should be allowed to idle and hot water, if available, should be added. If it is necessary to add cold water, it should be added very slowly.

Lubricating-oil System

- Q. How much oil should be carried in the engine-lubricating-oil system?
- A. The tank beneath the radiator should be filled to the level of the overflow pipe to the engine crankcase. The engine sump pan should be filled to at least midway between the low and full marks on the bayonet gage when engine is running. Do not let oil level fall below the low mark on the bayonet gage. Operating oil level should be checked after engine has been idling a few minutes.
- Q. What should be looked for if oil pressure does not build up when engine is started?
- A. Check to see that oil in engine sump is at proper level. Examine pressure-regulating by-pass valve to see if it is stuck open.
- Q. How does the lubricating-oil system operate?
- A. Oil is pumped from the lower engine sump, through the Michiana filter, and into the clean oil tank beneath the radiator. Another pump draws oil from this tank, forces it through the oil cooler in front of the radiator, circulates it through the Purolator filters on the left side of the engine, and delivers it at about 30 lb pressure to the main bearings, the crankpin bearings, piston-pin bearings, and valve-rocker mechanism, from whence it returns to the upper sump in the engine base, and then through the overflow pipe, to the lower sump.

Fuel-oil System

- Q. When and how often should fuel-oil filters on the engine be cleaned ?

QUESTIONS AND ANSWERS

- A. When pointer on fuel-pressure indicator on the diesel engine is in the red band, it is an indication that the filter elements are becoming clogged and should be renewed. When renewing, always install a complete new set of filters.
- Q. If engine does not get fuel, what should be looked for?
- A. See that there is sufficient fuel in tank. See that emergency trip valve is open. See that engine-stop button is pushed in. See if fuel pressure can be built up to operating value by using hand priming pump on right side of engine near fuel pressure gage. If not, check fuel lines to see if they leak air or oil, or are plugged by ice or dirt. Inspect priming pump, to see that plunger is screwed down snugly. Inspect check valve in transfer pump, to see that dirt has not lodged on seat.
- Q. How is fuel supply shut off in case of accident or fire?
- A. Pull one of the emergency fuel-cutoff pull rings. One is located in the cab and one on the side of the locomotive.
- Q. How is fuel delivered from the tank under the locomotive to the injection pump on the engine?
- A. Fuel is drawn from the bottom of the fuel tank by the transfer pump on the right side of the engine, and fed at a pressure of about 15 lb through the fuel-oil filters to the fuel injection pump. The excess fuel drains back to the main tank through a drain pipe. A hand-operated pump, located beside the transfer pump, is provided to prime the transfer pump in case the fuel tank has run dry or an air leak has developed in the fuel system.

Electric System

- Q. What is the voltage of the storage battery?
- A. Sixty-four volts.
- Q. What is the purpose of the reverse-current relay?
- A. This device automatically connects the auxiliary generator to the battery for charging, and prevents the battery from feeding back into the auxiliary generator if the generator voltage falls below the battery voltage.
- Q. How can it be determined when a traction motor is damaged, burned out, or short-circuited?
- A. Lack of power, jerking, smoke, or odor of burning insulation from under platform.
- Q. How are traction motors cut out?

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- A. By opening motor cutout switches in cabinet beside the master controller. There is one switch for each motor. Motors are numbered, beginning with No. 1 at the end of the locomotive marked F.
- Q. When a motor is cut out, what precautions should be observed in operating the locomotive?
- A. Open the throttle with extreme care. Do not use full power. Limit load to one half normal.
- Q. Should the reverse handle be in any position other than that of the locomotive direction?
- A. No. The reverse handle must never be shifted to the opposite direction until the locomotive has come to a complete stop.

Diesel-engine Operation

- Q. How is diesel engine started after standing shut-down for several hours?
- A. If temperature is below 50 F, warm diesel engine by lighting the kerosene heater. See that everything is clear in the engine room. Close battery switch. Be sure throttle is in Idle position and reverse handle Off. See that compression-release lever and engine shutdown lever are in the Run position. Close control switch. Press engine-start button, holding it down until engine fires. See that lubricating-oil pressure builds up.
- Q. What is maximum speed at which the diesel engine may be run to pump air when locomotive is standing?
- A. Diesel engine may be run at full speed, if required.
- Q. How is diesel engine started by battery?
- A. The generator is used temporarily as a series motor, and is furnished with power by the storage battery.
- Q. What is the reason for carrying a barring-over tool for turning the engine over by hand, and what precautions must be observed when it is used ?
- A. This barring-over tool is used for turning the diesel engine over when checking and adjusting valve settings and injector timing. Throw compression-relief lever to Start position. Care should be exercised in using this tool, to prevent injury from kickback caused by engine compression. Be sure diesel-engine stop button is in Stop position before barring-over engine. Remove tool before starting engine, to avoid damage to equipment and to prevent personal injuries.

QUESTIONS AND ANSWERS

- Q. If engine rotates but does not fire, what procedure should be followed to determine the trouble?
- A. See that there is sufficient fuel in the supply tank. Be sure that compression-release lever is in Run position. Be sure that engine shutdown button is in Run position. See that fuel is actually reaching the injection pump on the engine.
- Q. After diesel engine has started, what precautions should engineman take?
- A. Be sure lubricating-oil pressure builds up. If no pressure shows on the gage, stop the engine immediately. Be sure engine cooling system is filled according to season, and that water is circulating properly. Do not attempt to load engine by pulling train until engine has been thoroughly warmed up and temperature indicator shows between 140 F and 180 F.
- Q. What precautions should be taken in stopping engine?
- A. It is good practice to idle the diesel engine for five minutes before stopping.
- Q. How is the diesel engine stopped?
- A. By pulling diesel-engine shutdown button Out and holding it there until the engine stops.
- Q. How is movement of engineman's throttle transmitted to the injector pump?
- A. The engineman's throttle, through a system of mechanical linkage, controls the speed setting of the engine governor which, in turn, controls the injection-pump fuel rack.
- Q. How does the governor operate?
- A. The governor is of the mechanical type in which the centrifugal force of revolving weights is used to regulate the position of the fuel rack, to maintain the speed called for by the position of the engineman's throttle.

Locomotive Operation

- Q. Regardless of the completeness of the existing system of maintenance and inspection, what inspections should be made prior to starting work with the locomotive?
- A. The following should be checked daily:
Fuel, cooling water, lubricating oil, and sand.
Lubricating oil, and fuel and air pressures after the diesel engine is started. Test air brakes On and Off before moving locomotive.
- Q. How is locomotive started? Speed increased? Decreased?

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- A. Locomotive is started by moving the reverse handle to either the Forward or Reverse position; releasing the air brakes and steadily opening the throttle. Locomotive speed is increased by further opening the throttle. Speed is decreased by closing the throttle, and applying brakes if necessary.
- Q. What should the engineer do just before leaving the locomotive at the completion of his run, when the locomotive is not to -be run immediately under its own power?
- A. Set hand brake. Open all switches, including all light switches and main battery switch. Close all doors, windows, roof hatches, and radiator shutters. If freezing weather is at hand or expected, and locomotive is laid up outside or in an unheated building, be sure engine cooling system is filled with an adequate antifreeze solution, or else completely drain radiator and engine block.
- Q. What should be done if the locomotive is to be hauled dead in a train?
- A. Open main battery switch. Place reverse handle in Off position. Close double-heading cock below brake valve, and open dead-engine cock. Place automatic-brake valve in Running position. *Pull motor pinions if speed is to be over 35 mph.*
- Q. How are traction-motor axle-suspension bearings lubricated?
- A. These bearings are lubricated automatically from oil in the gear case. Maintain oil level even with filling hole. Use only oil designated for this purpose.
- Q. What troubles cause fan failures?
- A. Loose or broken belts. Lack of lubrication of fan bearings.
- Q. What are some air-compressor troubles?
- A. Loose or broken belts. Air-compressor-governor failure. Sticky or plugged valves. Internal trouble inside of compressor. Q. When and how should sand be used?
- A. Only when rail conditions make its use absolutely necessary. The abrasive action of sand, if blown into electric motors and generators, is highly detrimental. Always close throttle to remove power from motors before applying sand.
- Q. How can locomotive be railed if only one truck is off the track?
- A. Proceed as with all rerailed jobs. The truck on the track can be used to pull the locomotive back. Cut out motors in the derailed truck and apply power slowly to the other truck by opening throttle carefully. Watch load indicator, to prevent damage to motors on live truck.

Appendix

The following is a suggested Engineman's Daily Report, which can be very helpful in providing daily inspection data on locomotive operation. It will also serve to aid the maintenance crew in locating trouble.

ENGINEMAN'S DAILY REPORT

380-HP, 44-TON DIESEL-ELECTRIC LOCOMOTIVE

Road Number: _____

Date _____ 19____ Shift _____ A.M. _____ A.M.
 _____ P. M. to _____ P.M.

Engine Maximum

Operating Temperature No. 1 _____ No. 2 _____

Lubricating-oil Pressure	No. 1 _____	No. 2 _____
Fuel-oil Pressure	No. 1 _____	No. 2 _____
Exhaust Clear	No. 1 _____	No. 2 _____
Exhaust Smoke	No. 1 _____	No. 2 _____
Leaks: Lubricating Oil	OK _____	Trouble _____
Fuel Oil	OK _____	Trouble _____
Water	OK _____	Trouble _____
Battery Charge No. 1	OK _____	Trouble _____
No. 2	OK _____	Trouble _____
Brakes	OK _____	Trouble _____
Lights	OK _____	Out _____
Fuses	OK _____	Blown _____
Electrical	OK _____	Trouble _____

Remarks _____

By _____ Engineman Time of Report _____ A.M.
 _____ P.M.

To be submitted to maintainer daily.